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BEHAVIORAL ANALYSIS OF MOTIVATIONAL AND EMOTIONAL INTERACTIONS --ETC(U)
APR 78 J V BRADY, H H EMURIAN   N00014-77-C-0498

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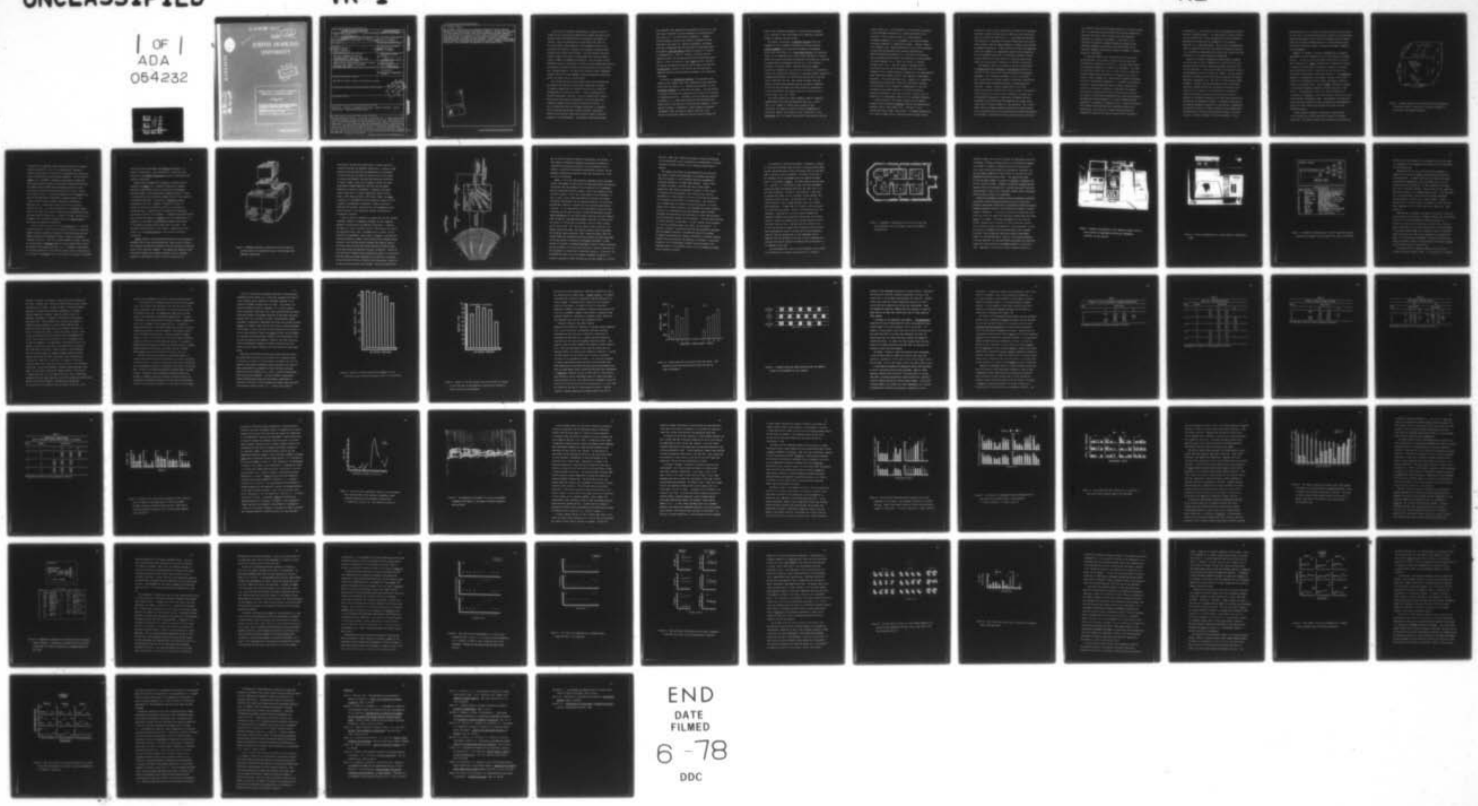

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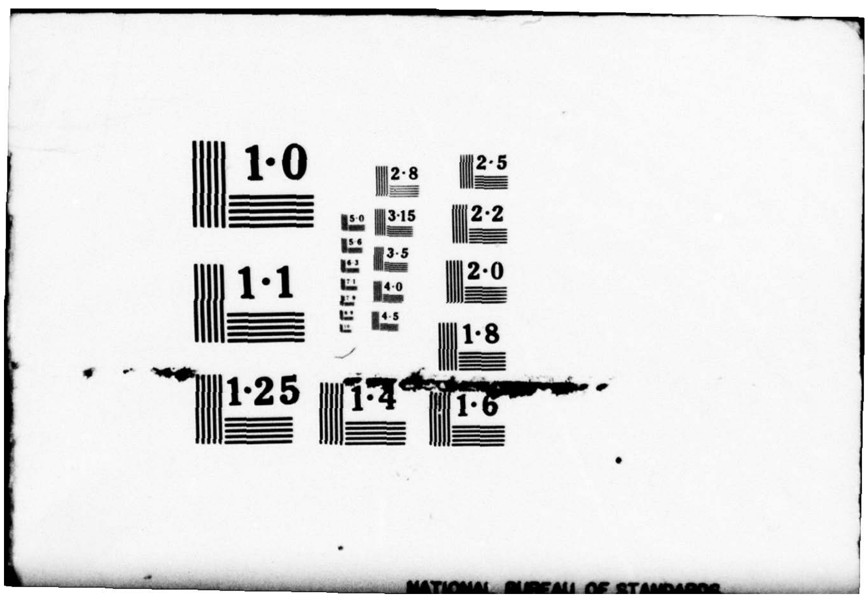
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BEHAVIORAL ANALYSIS OF MOTIVATIONAL AND EMOTIONAL INTERACTIONS IN A PROGRAMMED ENVIRONMENT

TECHNICAL REPORT
#1

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An interbehavioral analysis is provided as the basis for a unifying operational framework encompassing motivational and emotional functions. Within this context, a research environment has been designed for the conduct of small group experiments in a self-contained laboratory programmed to provide individual and social work and recreational opportunities during continuous residence by volunteer human subjects over extended time periods. Initial studies with groups of two or three individuals served to evaluate and optimize conditions (over)

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20. Abstract (cont.)

which enhance habitability and performance productivity during intervals extending up to several weeks of continuous residence. The baseline individual and social behaviors observed under such programmed environment conditions were then utilized in a series of 10 and 15 day, three-person experiments to study the effects of cooperative and non-cooperative social contingency arrangements upon individual and group behavior. Recent studies have focused upon an analysis of motivational and emotional effects produced by experimental variations in the programmed consequences of required work tasks.

The historical precedents established by a century or more of theoretical and investigative endeavor bear eloquent testimony to the abiding concern with the motivational and emotional attributes of behavior. While the observations to which these terms refer are not easily denied, many subtleties in the phenomena continue to be obscured by the semantic, linguistic, and taxonomic conventions which determine their popular use and abuse. Even the technical and quasi-technical usage of the terms as unitary behavioral referents tends to confuse a number of fundamental distinctions. Not the least of these ambiguities arises in the context of differentiations between motivational and emotional functions based upon attributions which are, for the most part, response-inferred. The need, thus revealed, to base independent variable distinctions upon dependent variable designations should warn against the obvious perils to sound theory.

The ultimate validity of the concepts which focus attention upon motivational and emotional functions must nonetheless be sought, if anywhere, among behavioral indicators which can be related and distinguished on the basis of lawful variation in parametrically analyzed experimental situations. Such an interbehavioral analysis would provide the essential foundation of a unifying operational framework encompassing motivational and emotional functions. A basic building block for this systematic formulation is suggested by the "three-term contingency" analysis (Skinner, 1969) which identifies and specifies controlling relations between "occasions", "behavior", and "consequences". The dominant relationship between

these component terms emphasizes the governance of action (i.e., the likelihood of "behavior") by the contingently occurring effects of that action (i.e., its reinforcing "consequences"). Emergent relations between "occasion" and "behavior" components are also specified to the extent that "behavior-consequence" contingency relations are dependent upon the occurrence of occasioning events. More complex interrelationships between the terms can, of course, be elaborated (e.g., "rule" or "schedule" relations) and must necessarily enter into the precise definition of behavioral contingencies. Within the context of these common empirical referents, motivational and emotional functions can be usefully analyzed and differentiated in terms of their effects upon distinguishable components (and/or relations between components) of the three-term contingency.

An analysis of motivational functions, thus expressed, would proceed, in the simplest case, with a primary focus upon operations which affect the potency (i.e., "potentiating operations") of the consequence component of a behavioral contingency. Food deprivation, for example, potentiates the consequence and increases the likelihood of consumatory behaviors. Conversely, nutritive ingestion attenuates the potency (i.e., reinforcing function) of food and defines the opposite pole of the same class of motivational procedures. In more complex instances, as elaborated in recent conceptual extensions (Goldiamond, 1978), the analysis requires attention to the effects of motivational operations upon the relations between the

behavior and consequence components of the three-term contingency (e.g., schedules of food reinforcement which temporally distribute periods of ingestion and deprivation).

By contrast, the analysis of emotional functions within the framework of such a systematic formulation would focus upon the occasion component of the three-term contingency and procedures which affect the efficacy (i.e., discriminant function) of occasioning events. As an elementary case in point, abrupt and episodic "startle" effects may disrupt occasioning circumstances and decrease the likelihood of ongoing behavior-consequence relations (e.g., food ingestion). Conversely, "orienting" and/or "alerting" effects may augment occasioning circumstances (e.g., amplify the salience of discriminative stimuli) and increase the likelihood (e.g., decrease response latency) of a consequated performance, thus defining the opposite pole of the same class of emotional functions. More complex instances requiring analysis of the relations between occasion and behavior components of the three-term contingency have been extensively elaborated in previous experimental and conceptual accounts of emotional interactions (Brady, 1970, 1971, 1975a).

The formal simplicity of these statements, shorn of subjective unobservables and the inferred mediational terms (e.g., "drive", "fear", etc.) common in linearly causal accounts of both "motivation" and "emotion" should not obscure accommodation of the obvious "somatic" participants in such interactions. In the motivational case, for example, physiological interventions, specified

either directly (e.g., cell dehydration) or as functional equivalents of other defineable operations (e.g., water deprivation) can be expressed in terms of making potent (i.e., potentiating) a contingency component (e.g., a consequence), the relations between contingency components, or combinations thereof. Prominent "associative" features (e.g., "acquired motivation") can as well be analyzed by specifying the operations which generate conditioned and generalized potentiating effects (e.g., "pairing" and "chaining"), and by characterizing the temporal and quantitative relations between continency components (e.g., "delay" and "amount" of "reward", "response cost", etc.). Even the "hedonic" characteristics of motivational functions can be accommmodated within the empirical framework of this conceptual analysis by appealing to the experimentally-based distinctions between "positive" and "negative" reinforcement operations. The evident byproducts (e.g., "euphoria") of "appetitive" consequating relations which increase the likelihood of behavior, on the one hand, and the "dysphoric" accompaniments of "aversive" consequences which weaken behavior (or strengthen escape and avoidance performances), would seem to provide a fruitful point of departure for the experimental analysis of this eudaemonic dimension.

A similar analysis of the somatic, associative, and hedonic dimensions which characterize <u>emotional</u> functions has emphasized the prominent role of "inner events" (e.g., "feelings") in such interactions (Brady, 1975a). Significantly, if somewhat paradoxically, this "radically behaviorisitic" approach neither excludes internal

processes nor requires their reformulation in terms of the "convergent operations" (Garner, Hake and Eriksen, 1956) which have traditionally served to exhaust their definition (i.e., conventional operationism). The acceptance of a meaningful distinction between public and private events, however, does not impose adherence to linearly causal accounts of emotional interactions. Rather, both sets of events are emphasized within the framework of an experimental analysis which presumes only that the procedures found useful in providing a scientific account of public behavior will prove fruitful in analyzing those private events which participate so prominently in emotional interactions.

The conceptual clarity of an empirical analysis which purports to differentiate between emotional and motivational operations on the basis of their effects upon selective "occasion" and "consequence" components of the three-term contingency is put to its severest test in providing an articulate account of the evident interrelationships between these interacting functions in complex behavioral situations. Indeed, it could be argued that in all but the theoretically purest (and empirically rarest) of cases, the definition and differentiation of motivational and emotional influences upon distinguishable components of a behavioral contingency should be formulated in functional terms which emphasize the "primary locus" rather than the "exclusive domain" of such operations. But it would appear that the conceptual problems involved may arise more from the social conventions and cultural conditioning which burden "motivational" and "emotional" vocabularies with excess meaning than from the logic

of an empirical analysis which eschews semantics ("a rose by any other name...") and focuses upon the differential functional properties of operations which exert unique influences upon distinguishable components of a behavioral contingency. In any event, such a formulation may provide a somewhat different and hopefully more operational approach to parceling out the contributions of the functional components which make up interacting segments of ongoing behavioral transactions.

In what would appear to be a most obvious case of such interacting operations, for example, a singular event may share both motivational and emotional functions (i.e., influence both occasion and consequence components of a behavioral contingency). The sight of blood (particularly one's own!) is likely not only to affect the occasion controlling eating behavior, for example, but as well to result in somatic changes (e.g., nausea) which attenuate the potency of food as a maintaining consequence (i.e., decrease its reinforcing function). Equally common would seem to be those instances which involve the simultaneous occurrence of independent and separable (but obviously interacting) motivational and emotional operations. The context in which these distinguishable but concurrent motivational and emotional functions emerge will, of course, determine whether synergistic or antagonistic interactions result. Emotional operations which enhance the discriminability of occasioning events (e.g., alerting) may, on the one hand, interact synergistically with independently identified motivational operations which "energize" a

performance (e.g., the intensity of aversive consequences maintaining escape or avoidance behavior). The same emotional alerting functions may, on the other hand, interact antagonistically with motivational operations which potentiate the consequence of less energetic behaviors (e.g., sleep deprivation). And, of course, topographically identical operations may at one time subserve motivational functions (i.e., potentiate a consequence) and at other times subserve emotional functions (i.e., enhance occasioning circumstances).

Temporal and sequential dependencies between behavior segments can also be seen to play an important role in determining the interrelationships and functional interactions between motivational and emotional operations. Prior-occurring behavior-consequence relations and attendant motivational functions, for example, can exert powerful emotional influences upon the occasioning circumstances for ensuing behavioral contingencies (e.g., the "joy" of victory and the "agony" of defeat). Moreover, the form and extent of these interactional complexities between motivational and emotional functions, as they emerge within the context of shifting behavioral contingencies, approach mind-boggling proportions when the multiple somatic, associative, and hedonic dimensions of the participant processes are parceled out for experimental analysis. The method of dealing with such complex phenomena by resolution or reduction has a longstanding and productive history in scientific thought and the schemata which have proven useful for most discourse within science (in the sense of public, consensual exchange) are often represented in a two-

dimensional plane (i.e., xy axes) in which verfication and falsification can take place. The interacting biological, behavioral and psychological complexities presented by motivational and emotional functions however, would seem to require conceptualization of a three-dimensional space within which the multiple somatic, associative and hedonic dimensions can be encompassed.

Figure 1, for example, illustrates diagrammatically a composite topographic-functional framework for such a multidimensional schematic analysis. By way of at least preliminary specification of relevant basic constructs, the "somatic" dimension can be operationally defined in terms of the broad range of biochemical, anatomical, and physiological participants (both "inside" and "outside" the skin) which participate in motivational and emotional functions. The "associative" dimension is represented by the prominent "learning" effects (both historical and contemporary) which reflect the temporal ordering of stimulus and response events. And the "hedonic" dimension is defined by the emergent eudaemonic properties of somatic-associative interactions. As conceptualized, each of the indicated dimensions is considered to be inclusive in that each encompasses the entire universe of motivational and emotional events. The parameters and interactive features of these constructs in turn, delineate the three-dimensional space within which analysis and discourse would seem to be most profitably pursued.

Indeed, essential parametric delineation of these multiple inclusive dimensions presents operational problems of formidable proportions. The evident continua which characterize such dimensional

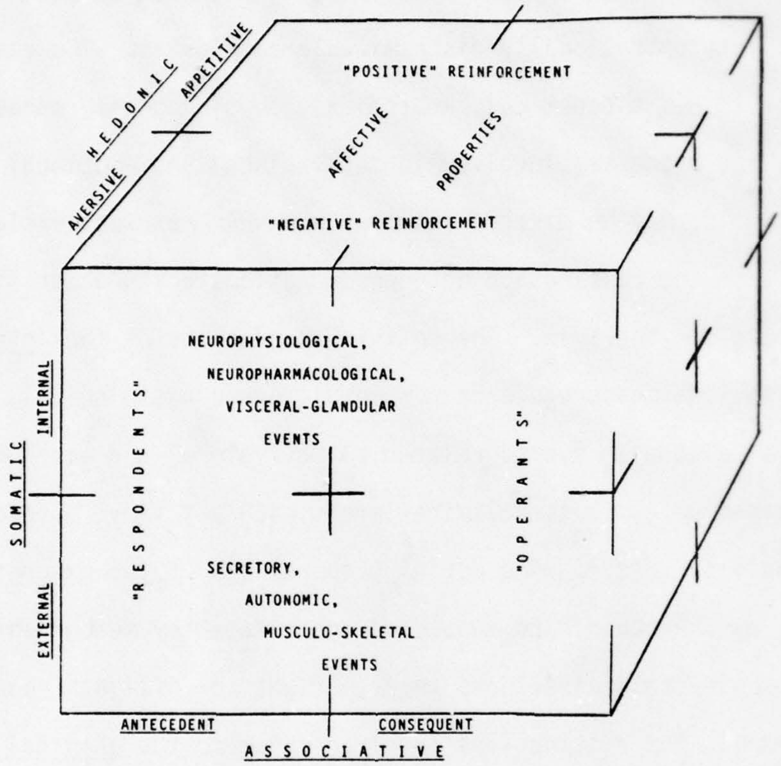


Figure 1. Schematic diagram of three-dimensional space encompassing the multiple somatic, associative, and hedonic parameters of motivational and emotional functions.

formulations will doubtless require analogical analysis for accurate and precise definition. But a first approximation "analogue-to-digital" conversion may at least serve to dichotomize such continuous arrays into operationally-discriminable categories. The vast array of somatic (i.e., biochemical, anatomical, physiological, behavioral) events and processes involved in motivational and emotional functions, for example, may be divided into two reasonably exclusive classes based upon the distinction between operations which occur "inside" and "outside" the skin. The defining operations of the internal class would include measureable neurohumoral, neurophysiological, and visceral-glandular events related to motivatonal and emotional operations (e.g., catecholamine levels, EEG activity, autonomic responsivity, etc.). The defining operations of the external somatic class, on the other hand, would be constituted by measureable secretory and musculo-skeletal effects (e.g., "fight" or "flight" reactions, etc.). In general, the distinctions involved refer to the physical locus of motivational and emotional interactions.

A similar "digital conversion" for the associative (i.e., learning) processes involved in motivational and emotional functions distinguishes between two broad categories of behavioral interactions based upon the temporal ordering of environmental "stimulus" events and organismic "response" activities. The first of these parametric classes is defined by the occurrence of antecedent events in the environment (both internal and external) which elicit activities (i.e., "respondent" interactions). The defining operations of the second associative class are characterized by occurrence of consequent events in the internal and external environment

which follow and are contingent upon _emitted_ performances (i.e., "operant" interactions). These "associative" distinctions refer primarily to the _temporal relationships_ involved in motivational and emotional interactions.

Somewhat more problematically (consensual validation notwithstanding), the _hedonic_ (i.e., affective) properties of somatic/associative interactions involved in motivational and emotional functions suggest a first approximation parametric analysis in terms of experimentally-based distinctions between "positive" and "negative" reinforcement operations. The positive or _appetitive_ category represented in the third eudaemonic dimension of Figure 1 is defined (in obviously oversimplified form) by the occurrence of consequences (e.g., "euphoria") which strengthen the performances upon which such effects are contingent. A comparable oversimplification would identify the negative or _aversive_ class with consequences (e.g., "dysphoria") which weaken the performances producing such effects or strengthening responses which prevent their occurrence. This dichotomous characterization of the "hedonic" dimension would refer primarily to the _affective valence_ of motivational and emotional interactions.

Figure 2 presents a more detailed specification of the interacting components which occupy the multidimensional space outlined in Figure 1 and delineates the operational elements which form the empirical building blocks of this conceptual schematic. The temporal and sequential interrelationships between these component elements provide a systematic framework for experimental analysis of both the behavioral and

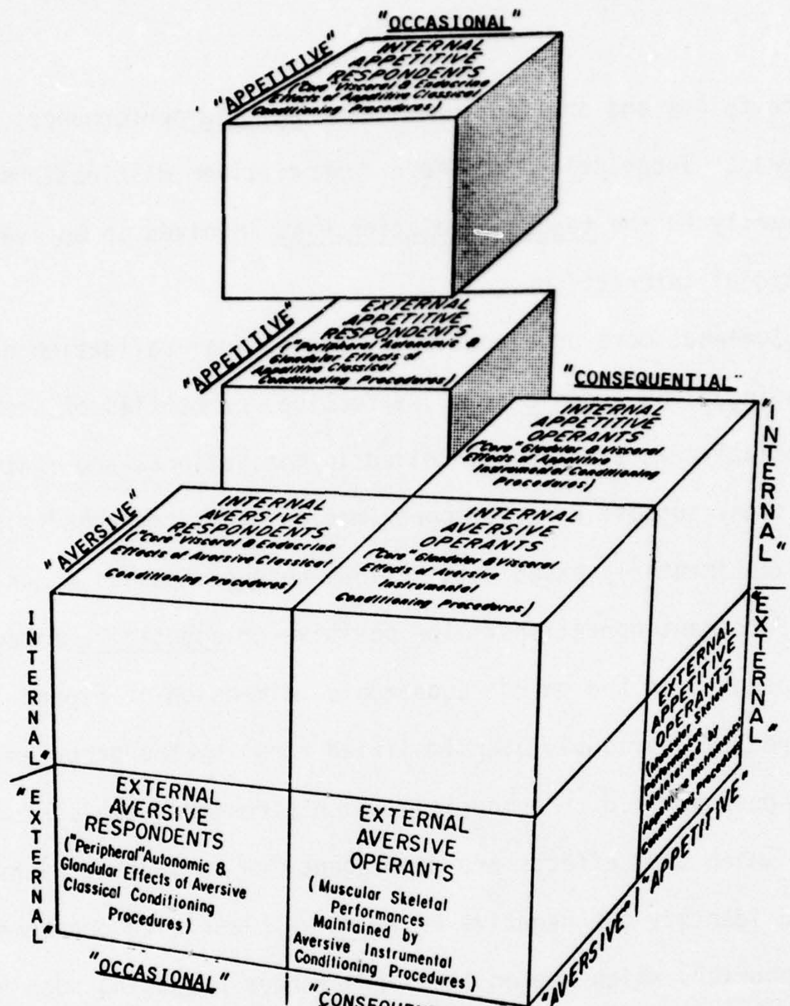


Figure 2. Component operational elements which provide empirical building blocks for experimental analysis of motivational and emotional interactions.

physiological processes which participate in complex and multi-faceted motivational and emotional interactions. A range of animal laboratory studies addressing the commonalities and differences in such motivational and emotional functions have in fact begun to analyze experimentally the constituent operations identified in Figure 2 (Brady, 1975a), and to examine in detail the inter-relationships between behavioral activities and the broader patterning or balance of biochemical, anatomical, and physiological events which in concert regulate the internal milieu (Brady, 1975b; Brady and Harris, 1976; Mason, 1968). And Figure 3 summarizes in diagrammatic form the integrative features of this systematic interbehavioral formulation in terms of the multi-dimensional determinants, both historical and contemporary, which provide the basis for an operational analysis of motivational and emotional functions.

It may, of course, be premature to suggest that any such unifying conceptual framework can adequately encompass the full range and complexity of motivational and emotional interactions. Certainly, the model will require systematic analysis with regard to its novelty and comprehensiveness, gaps in knowledge which it reveals, and new directions of experimental inquiry which it suggests. Some heuristic value may be derived, however, from an account which proceeds without recourse to the fruitless polemic exchanges over temporal ordering and linear causality which have marred prominently reified accounts of the motivational and emotional attributes of behavior. Rather the more operational framework herein proposed would appeal to the empirical relations among and between components of the three-term contingency and the functional analysis of behavior which experimental examination of these interrelationships have provided. While such reformulation

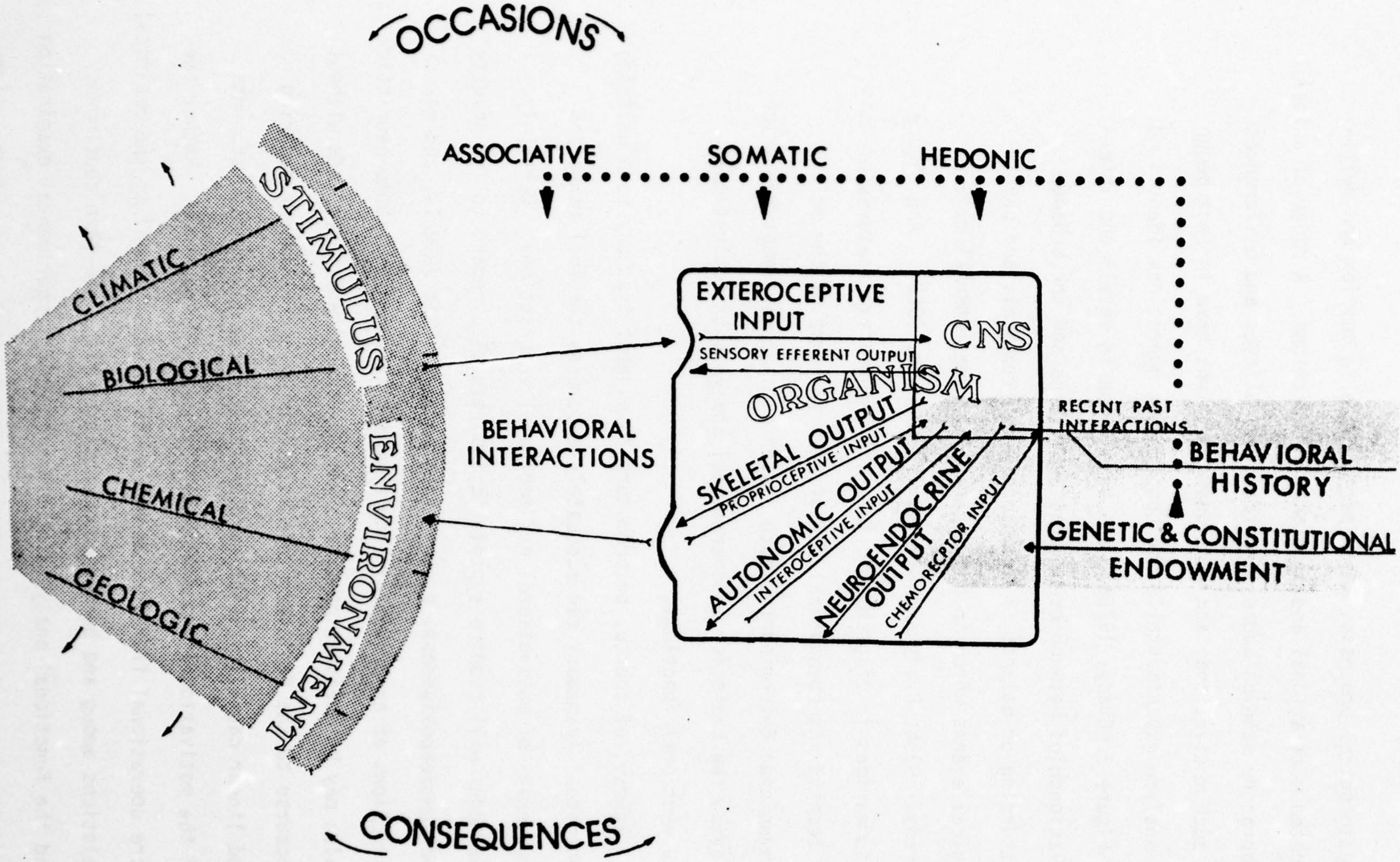


Figure 3. Integrative diagrammatic representation of the multi-dimensional historical and contemporary determinants of motivational and emotional functions.

may not solve the empirical problem of "motivation" and "emotion", it does suggest a different and hopefully more productive approach to conceptual and investigative analysis of both the general laws of behavior, as applied to motivational and emotional functions, and the parameter determinations required to make such laws operative in fact as well as in principle.

Indeed, it is to the latter problem of parameter values and methodological requirements for the analysis of human motivational and emotional interactions that the remainder of this discussion will be addressed. Despite evident dedication and industry, the slow and somewhat halting scientific progress in this field would appear to be attributable, at least in part, to the limited availability of effective and relevant experimental methodologies for the interactive analysis of motivational and emotional functions in naturalistic but controlled human behavior situations. In our laboratories at the Johns Hopkins University School of Medicine over the past few years, we have been developing an experimental methodology for the study of human individual and social behavior under residential "programmed environment" conditions which provide for the analysis of motivational and emotional functions (Brady, Bigelow, Emurian and Williams, 1974; Emurian, Bigelow, Brady and Emurian, 1975; Bigelow, Emurian and Brady, 1975; Emurian, Emurian, Bigelow and Brady, 1976; Emurian, Emurian and Brady, 1978). Findley and Brady (1963) and Findley (1966) have provided a discursive rationale and preliminary model for the application of continuously programmed environments in human research on the basis of extended experimental control, objective recording, and the maintenance of realistic and naturalistic incentive conditions for the assessment of a broad range of behavioral processes. In addition, the development and application of contingency management procedures in a variety of naturalistic social settings over the past decade (e.g., Ayllon

and Azrin, 1968; Cohen, 1968) have provided an effective methodology for the experimental control, manipulation, and measurement of relevant individual and group variables in such laboratory human behavior research.

The research environment has been designed and constructed for the conduct of small group experiments over extended time periods within the context of a self-contained laboratory programmed for continuous residency by volunteer human subjects. Groups of male and female volunteers, recruited from local college student communities, have served as experimental subjects in these studies. All subjects receive psychometric test evaluation and interview assessment by a staff psychiatrist as part of the screening procedure for acceptance as participants in the experiments. Each subject is fully informed about the research setting and procedure, to include several daily briefing sessions in the programmed environment preceding the start of an experiment during which monetary rewards are made contingent upon satisfactory task performance to insure familiarization with the operational features of the laboratory. Following these briefings, but before beginning an experiment, a written informed consent agreement is signed and exchanged between the subjects and experimenters. In addition, a manual of instructions detailing the experimental procedures and environmental resources is provided each subject for guidance throughout the experiment and retention thereafter for whatever reference purposes the participant may find necessary or desireable. Using these procedures, over 70 experimental subjects have participated in and completed upward of 30 residential studies in the programmed environment without untoward occurrence.

The residential laboratory environment is composed of a complex of five specially-designed rooms joined by an interconnecting common corridor constructed within a wing of the Phipps Clinic at the Johns Hopkins University School of Medicine. The overall floor plan of the laboratory and its arrangement within the external building shell is illustrated in Figure 4. The three identical private rooms ("P" - each 8½' x 11') are similar to small efficiency apartments containing kitchen and bathroom facilities, bed, desk, chair, rug and other furnishings. The social living area ("SL" - 14½' x 22½') is equipped with tables, chairs, sofa beds, storage cabinets, and a complete kitchen facility. The workshop ("WS" - 8½' x 13½') contains benches, stools, storage cabinets, tools, and a washer-dryer combination. A common bath ("B", Figure 4) serves the social living area and the workshop. Access to the exterior walls of the laboratory is provided by a 4 to 6 foot corridor between the residential chambers and the external building shell which permits transfer of supplies and materials thru two-way storage facilities accessible from both sides. Remotely controlled solenoid locks on doors and cabinets throughout the environment provide for experimental programming of access to various facilities and resources, though at least one unlocked door in each compartment permits departure from the laboratory at any time in case of emergency and preserves the right of subjects to terminate their participation in an experiment at any time.

The electromechanical control devices throughout the environment are interfaced with a computer system located in an adjoining

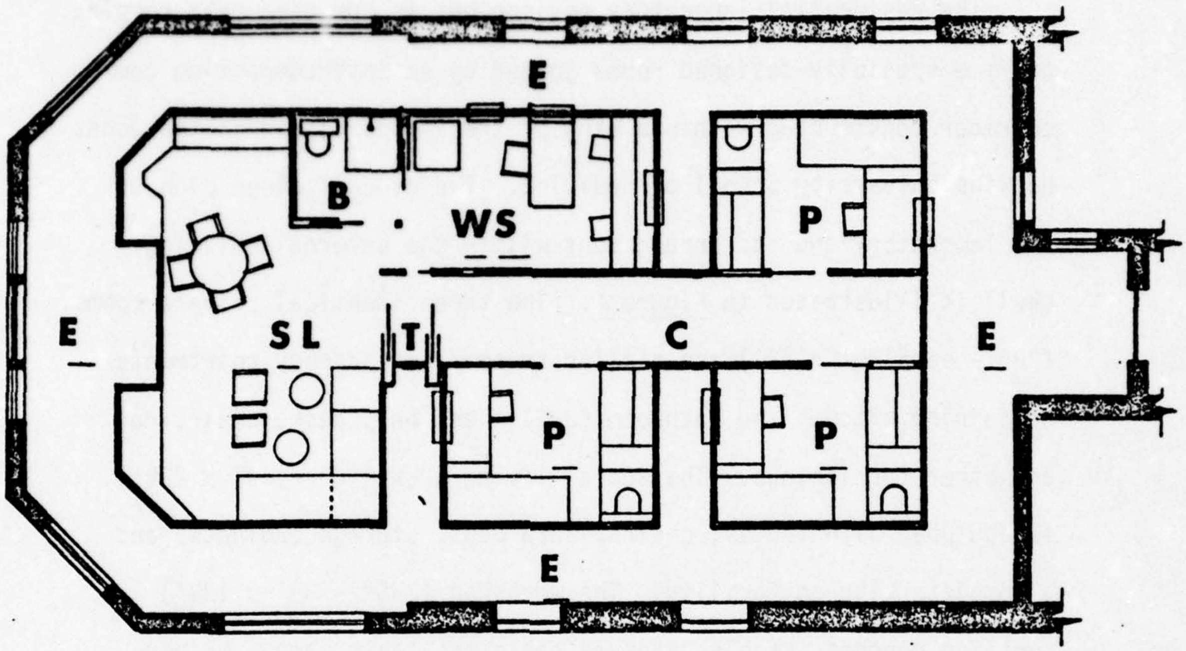


Figure 4. Diagrammatic representation of the overall floor plan of the laboratory and its arrangement within the external building shell.

laboratory support facility which provides for experimental monitoring, programming, recording, and data analysis, as illustrated in Figure 5. The computer is linked to a Cathode Ray Tube (CRT) Display Device within each of the private rooms of the residential laboratory, and an alpha-numeric keyboard with each display unit provides for direct communication with the system control. The communication panel in each individual chamber, illustrated in Figure 6, incorporates the CRT unit and also includes a telephone intercom for exchanges between subjects within the environment and a cassette tape player. Audio and video equipment in each of the residential chambers permits continuous monitoring during conduct of an experiment.

Behavioral programming procedures have been developed to establish and maintain stable performance baselines as well as provide for systematic experimental manipulation of performance interactions during extended residential studies in the laboratory environment. A behavior program is defined by: 1) an array of activities or behavioral units, and 2) the rules which govern the relationship between these activities. Figure 7, for example, illustrates diagrammatically the fixed and optional sequences which characterize a typical behavioral program used to establish baseline performances for these experiments, as well as the array of component activities which make up such a program. Variations in this program as required for specific experimental studies will be described below. Each box in the diagram represents a distinct behavioral unit and performance requirement, with progression through the various activities programmed sequentially from left to right. Regardless of the fixed or optional sequence selected, all

Figure 5. Pictorial representation of the laboratory support facility which provides for experimental monitoring, programming, recording, and data analysis.

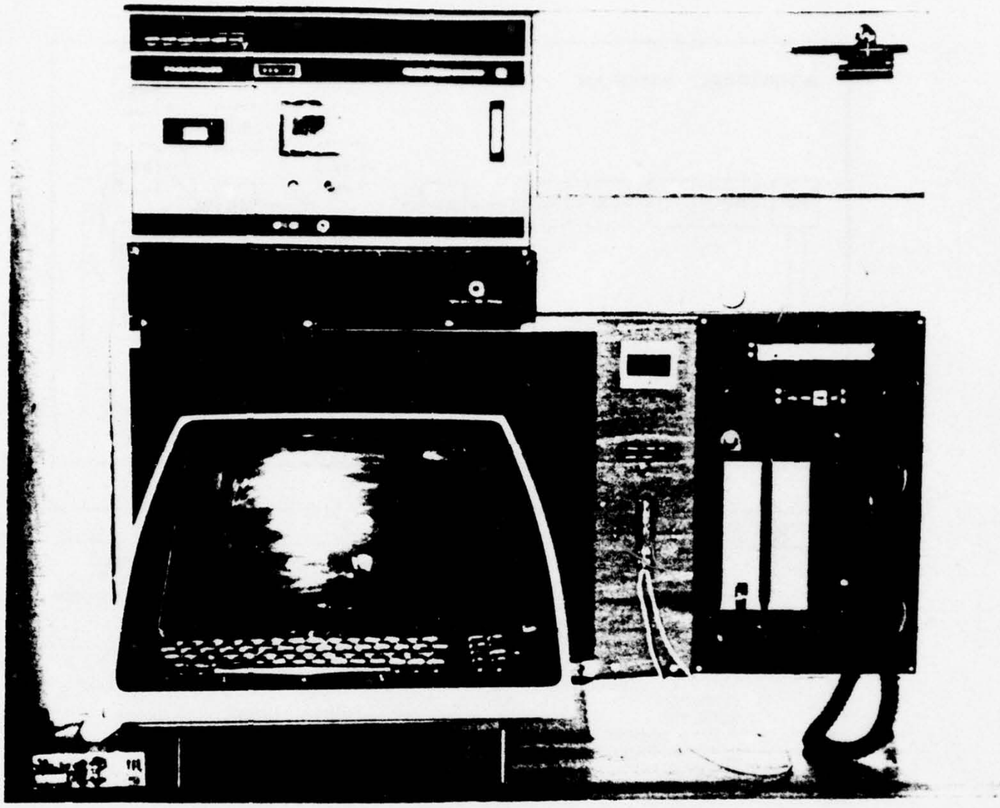
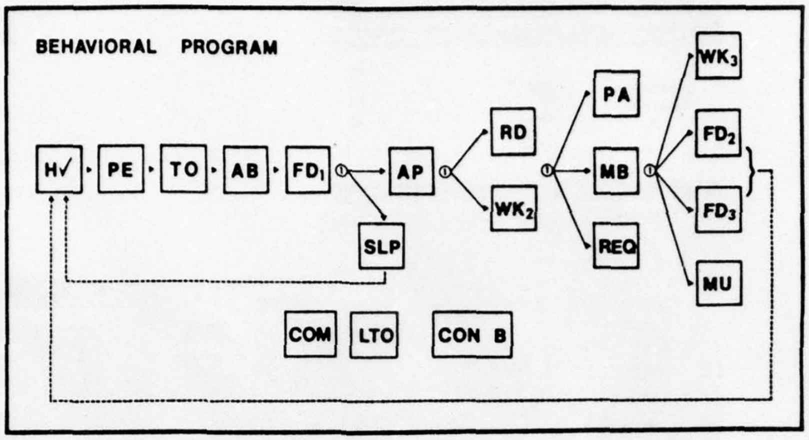


Figure 6. Pictoral representation of a single subject's communication panel.



INVENTORY OF ACTIVITIES

NOTATION	FULL NAME	BRIEF DESCRIPTION
H✓	HEALTH CHECK	TEMPERATURE, PULSE, WEIGHT, STATUS REPORT
PE	PHYSICAL EXERCISE	300 CORRECT PRESSES ON AUTOMATED TASK
TO	TOILET OPERATIONS	USE OF PRIVATE BATHROOM AND CONTENTS OF DRAWER CONTAINING TOILETRIES, CLEAN CLOTHING
AB	AUTOGENIC BEHAVIOR	RELAXATION EXERCISES ON TAPE
FD1	FOOD ONE	TWO SELECTIONS FROM A LIST OF LIGHT FOODS
SLP	SLEEP	UNLIMITED USE OF BED
AP	ARITHMETIC PROBLEMS	100 CORRECT SOLUTIONS OF ARITHMETIC PROBLEMS
RD	READING	ACCESS TO BOOK
WK2	WORK TWO	PROBLEMS, EXPERIMENTS, ASSEMBLY PROJECTS
PA	PUZZLE ASSEMBLY	ASSEMBLE A PUZZLE
MB	MANUAL BEHAVIOR	ACCESS TO ART MATERIALS
REQ	REQUISITION	EARN DELAYED DELIVERY OF TREATS OR *REPLENISHMENT OF CONSUMABLES*
WK3	WORK THREE	SOCIAL, ACCESS TO COMMUNAL WORKSHOP
FD2	FOOD TWO	PRIVATE MAJOR MEAL
FD3	FOOD THREE	SOCIAL, MAJOR MEAL IN RECREATION ROOM, GAMES
MU	MUSIC	5000 LEVER PRESSES TO EARN A CASSETTE TAPE
COM	COMMUNICATION	ACCESS TO INTERCOM
LTO	LIMITED TOILET OPERATIONS	ACCESS TO ESSENTIAL TOILET FACILITIES
CON B	*CONDITION B*	*CHANGE IN PROGRAM CONDITION*

Figure 7. Diagrammatic representation of a typical behavioral program governing the sequential and contingent relationship of activities.

behavioral units are scheduled on a contingent basis such that access to a succeeding activity depends upon satisfaction of the requirement for the preceding unit.

Beginning at the far left, the fixed activity sequences is composed of all activities between and including Health Check (H√) and Food One (FD1). The Health Check activity requires the subject to determine his temperature, pulse, and weight, and to fill out subjective status questionnaires. He then completes the following activities in the order displayed: Physical Exercise (PE), requiring 300 correct responses on an automated exercise task; Toilet Operations (TO), providing access to the private-room bathroom and drawers containing towels, toiletries, and a vacuum cleaner; Autogenic Behavior (AB), in which the subject is permitted to select two items from a presented list of 10 light foods such as coffee, tea, soup, cereal, etc.

When Food One is completed, the subject is eligible to select one of the following two activities: Arithmetic Problems (AP), requiring 100 solutions on a series of mathematical problems presented on a cathode-ray display screen and keyboard; and Sleep (SLP), providing access to the bed for an unlimited time period of at least 30 minutes. If the subject selects Sleep, he is required to return to the Health Check activity and the fixed activity sequence at the completion of Sleep. This minimum recycling sequence is designed to maintain and assess the subject's health if he were otherwise indisposed to engage in the broader selection of opportunities.

The optional activity sequence commences with the choice of Arithmetic Problems instead of Sleep. At the completion of Arithmetic

Problems, the subject is eligible to select one of the following two activities: Reading (RD), providing at least 30-minute access to books contained within a drawer; or Work Two (WK2), in which the subject completes in private various problems, experiments, or assembly projects presented in a drawer. When the selected activity is completed, the subject is eligible to select one of the following three activities: Puzzle Assembly (PA), requiring the subject to assemble a puzzle presented in a drawer; Manual Behavior (MB), providing at least 30-minute access to art supplies contained in a drawer; or Requisition (REQ), allowing the subject to press a lever to earn at least one but not more than 30 points exchangeable for treats, such as soft drinks and pastries, or for consumables, such as soap and toothpaste. On completion of the selected activity, the subject is eligible to select one of the following four activities: Work Three (WK3), providing at least 30 minutes in the workshop by one, two or three subjects to complete assembly projects and maintenance chores; Food Two (FD2), requiring at least 30 minutes and providing the subject with a major meal to consume in the private room; Food Three (FD3), providing at least 30 minutes in the recreation room by one, two or three subjects to consume a major meal and to play games; or Music (MU), allowing the subject to press a lever to earn a cassette tape that can be played at any time. Once a subject has completed his choice among these four activities, he returns to Health Check and the fixed activity sequence, indicated by the dotted line.

The optional activity sequence allows the subject flexibility in the

selection and arrangement of activities, both individual and social.

At the bottom of the diagram are two activities with more general rules. The Limited Toilet Operations (LTO) activity, which allows access to essential toilet facilities, is the only activity that can be selected at any time. The Communication (COM) activity allows access to the intercom for intersubject communications. A subject is permitted to use the intercom to initiate or answer a communication only if he is between any two program activities. Although the Communication activity is available between any activities, an actual conversation requires at least two subjects' simultaneous presence within the Communication activity. Conversing subjects, however, whether in pairs or all three at once, could be located at different sequential positions within the behavioral program. For example, a Communication and conversation might occur when one subject is between Autogenic Behavior and Food One, and another subject is between Manual Behavior and the last column of activities, and so on.

The CON B notation at the bottom of the diagram refers to a program change determined by the requirements of a specific experiment, as described below. A manual of instructions detailing the program and use of environmental resources is contained in each room of the environment. An error in following the behavioral program causes a 5-second blackout. Subjects follow the behavioral program throughout the periods of residence, and pairs of research assistants monitor the experimental environment continuously with audio and video equipment located, with the subject's awareness, in each room of the environment.

Initially, preliminary environmental habitability and performance programming studies (Brady, et al, 1974) were conducted with groups of 2 and 3 subjects during intervals of continuous residence in the research environment ranging from 2 to 16 days. Only minimal (and basically biological) activity sequences (i.e., eating, sleeping, group recreational interactions, etc.) were required during the briefer exploratory periods, with gradual extensions of continuous residential periods from 1 to 3, and then to 10 days, introducing more complex programmatic sequencing of performance activities with successive groups. Figure 8, for example, shows the high and relatively stable percentage of time spent in social activities for two subjects over the course of such a 10-day residential study, and Figure 9 reflects the high degree of intersubject program synchrony evidenced by the percentage of time the same two subjects were engaged in identical individual activities or were simultaneously engaged in different individual activities within the same column of optional activities during the 10-day study period.

Based upon the finding that these small groups could not only be maintained under stress-free living conditions for extended periods of continuous residence in the experimental environment, but that the sequential contingency performance program developed in the course of these investigations was supportive of both individual and group behavioral activity (Emurian, et al, 1975), a series of program parameter studies were undertaken. The major purpose of these experimental manipulations focused upon the temporal determinants of behavioral interactions in the programmed environment under conditions of performance schedule "pacing" (i.e., imposed delays between

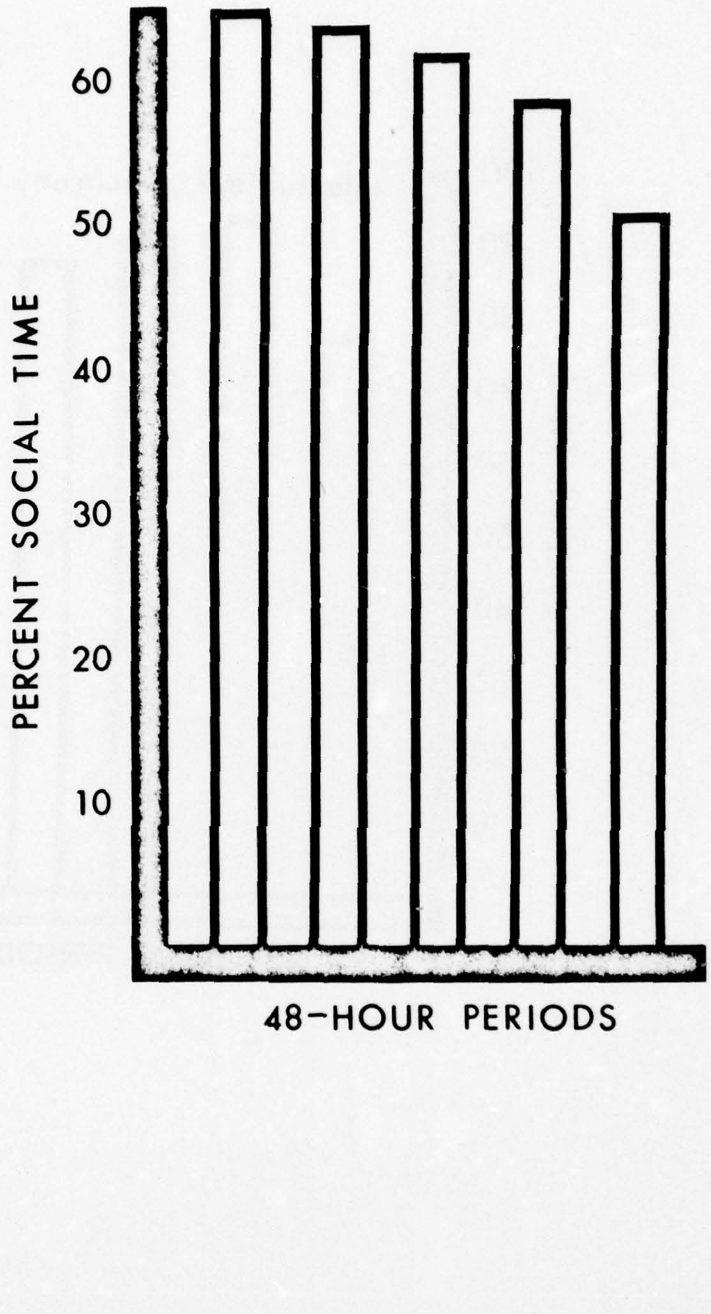


Figure 8. Percent of time that subjects were engaged in social activities, across consecutive 48-hour periods of the experiment.

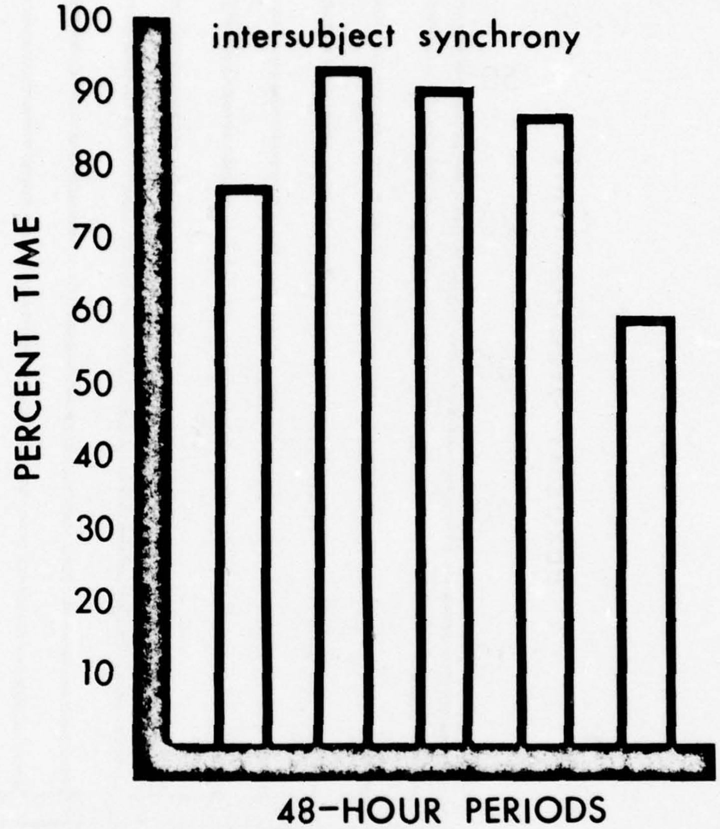


Figure 9. Percent of time that subjects were synchronized with respect to their positions in the behavioral program across consecutive 48-hour periods of the experiment.

activities) and upon extensions of continuous residential periods in the laboratory up to several weeks. Figures 10 and 11, for example, illustrate some of the more interesting incidental observations on orderly changes in sleep-wake cycles during one such residential study with two subjects. As shown in Figure 10, there was a progressive increase in the duration of successive wake periods with little or no systematic change in the duration of successive sleep intervals (Figure 11), resulting in a complete 12-hour reversal of the sleep-wake cycle over the 7-day residential period.

The major findings of these early studies emphasized the differential importance of selected program components (e.g., social activities) in maintaining individual and group performance and the sensitivity of behavioral interactions to experimental manipulations (e.g., program condition changes and reversals) over the course of extended residential periods. Consequently, a series of more systematic and extensive studies (Emurian, et al, 1976) were undertaken to focus upon the motivational and emotional effects of varying social interaction conditions in 5 groups of three subjects each for periods up to 15 days of continuous residence in the programmed environment. The scheduled arrangement of required and optional private and social activities described above determined the individual and group baseline performances upon which the experimental social interaction conditions were superimposed. A "cooperation" condition (C) was in effect when all three subjects were required to select simultaneous access to a group area before it became available for use. This condition was programmed by requiring that either of two activities within the group area (i.e., FD3 or WK3) was accessible only when all three subjects selected it together. Typically, subjects would use the intercom several activities in

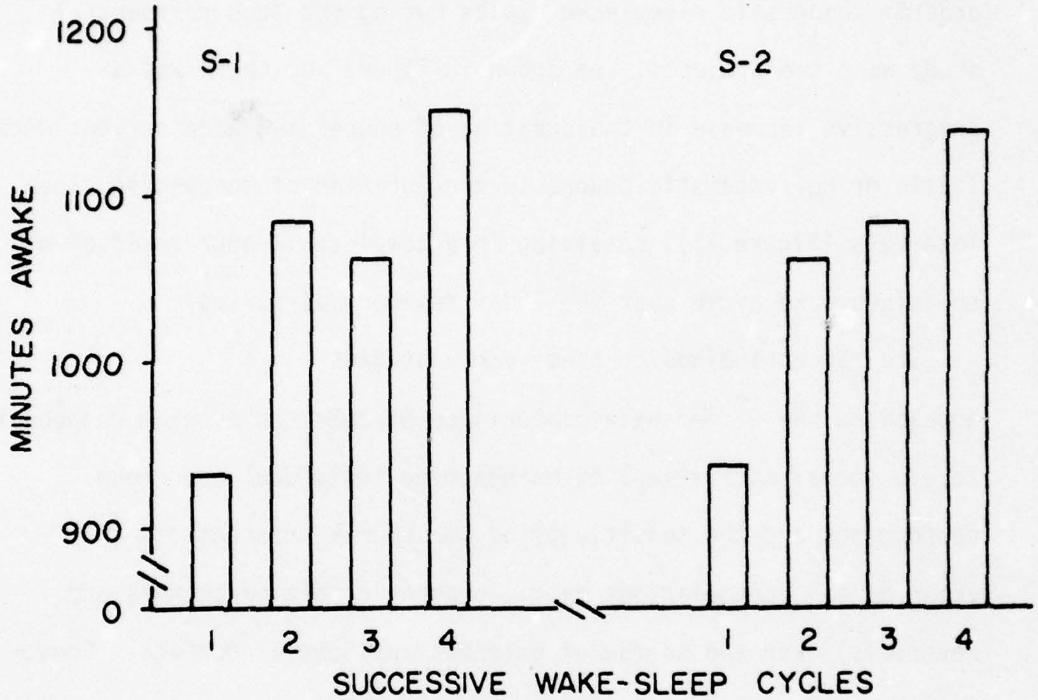


Figure 10. Minutes awake during successive wake-sleep cycles. Only consecutive waking periods bound both before and after by sleep are presented.

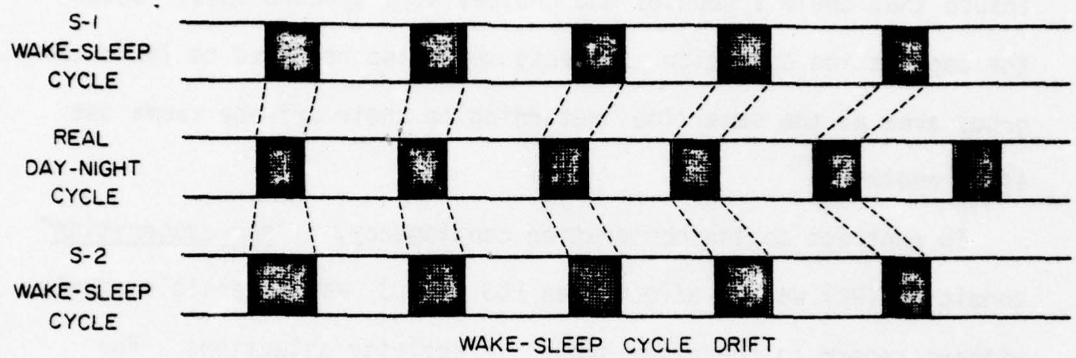


Figure 11. Successive wake and sleep durations across the temporal course of the experiment for both subjects.

advance to plan subsequent selection of a social activity. They would then pace their individual schedules accordingly to arrive at the choice point in the program at approximately the same time. Subjects almost always used the intercom immediately before FD3 or WK3 to insure that their schedules and choices were synchronized. Under the cooperation condition, subjects were also required to leave the group area at the same time, returning to their private rooms one after another.

In contrast to the cooperation contingency, a "non-cooperation" condition (NC) was in effect when FD3 or WK3 was accessible singly, without regard to the other subjects' activity selections. For example, a single subject could select FD3 or WK3 at the choice point and could then leave his private room immediately and enter the chosen group area even though the other subjects were engaged in private activities. Of course, the other subjects could also have access to the same group area at the same time, but they were not required to enter and leave together.

For Groups 1 through 5, these two conditions were investigated in the following order and number of successive days under each condition, respectively: C-NC-C (days: 4,3,3); NC-C-NC (days: 5,5,5); NC-C-NC (days: 4,3,3); C-NC-C (days: 4,3,3); and C-NC-C (days: 4,3,3).

A time sampling procedure was employed to monitor the occurrence of social interactions during triadic episodes. When all three subjects occupied either the social living area (FD3) or the workshop (WK3), 10-second observational samples occurred on a variable-interval schedule averaging 8 minutes between samples. During each 10-second sample, each subject was rated independently on a "yes/no" dichomotization reflecting the presence or absence of a social

interaction. A subject was rated as having exhibited a social interaction if he engaged in any of the following four behaviors: 1) any vocal utterance, 2) participation in social games, 3) physical contact with another subject, or 4) handling materials between subjects. The high degree of inter-rater reliability upon which these social interaction measures were based was reflected in a coefficient of correlation well above +.90.

The results of this experiment showed clearly that the systematic effects of such contingency management procedures could be discerned not only upon the social behavior of the group, but as well upon collateral individual behaviors which characterized performances within the continuously programmed environment. Enhanced levels of intersubject program synchronization (Table 1) and intercom frequencies (Table 2) were accompanied by comparable increases in the magnitude of triadic episodes during the cooperation condition. Not only the percent of total time spent in triadic social activities (Table 3), but the durations of triadic episodes (Table 4), combined with corresponding social interaction measures (Table 5) suggested a potentially important consequence of cooperation contingencies in maintaining more durable social interactions when continued access to the group areas accrued primarily as a result of the frequency of social interactions.

Cooperation contingency effects on triadic conditions would seem to be of particular significance when considered in light of group fragmentation effects observed during non-cooperation conditions. The distribution of dyadic percent times into two high-pairing subjects and one low-pairing subject within the groups, illustrated in Figure 12, suggests development of a two-man in-group and a relative social isolate during the non-cooperation condition. And

TABLE 1

PERCENT OF TIME IN INTERSUBJECT PROGRAM SYNCHRONIZATION

Group	Conditions[a]			
	C	NC	C	NC
1	55.5	18.6	47.4	-
2	-	24.4	27.9	20.0
3	-	35.5	48.7	54.6
4	73.8	45.7	67.8	-
5	64.6	49.3	70.8	-

[a]C=cooperation condition, NC=non-cooperation condition.

TABLE 2

MEAN DAILY INTERCOM SELECTIONS

Group	Subject	Conditions[a]			
		C	NC	C	NC
1	1	9.3	5.7	6.0	-
	2	5.5	0.3	2.7	-
	3	9.3	5.0	5.3	-
2	1	-	4.0	3.4	2.2
	2	-	2.4	2.2	0.8
	3	-	2.8	2.4	2.0
3	1	-	4.0	8.3	2.3
	2	-	3.8	8.0	3.7
	3	-	3.5	5.3	2.3
4	1	6.5	1.7	5.0	-
	2	5.8	3.3	4.7	-
	3	5.8	2.0	4.0	-
5	1	2.5	1.0	1.3	-
	2	2.5	1.7	1.3	-
	3	2.5	1.3	1.7	-

[a]C=cooperation condition, NC=non-cooperation condition.

TABLE 3

PERCENT OF TIME IN TRIADIC EPISODES

Group	Conditions[a]			
	C	NC	C	NC
1	25.8	12.5	34.9	-
2	-	4.0	8.8	1.9
3	-	21.2	17.9	14.1
4	28.2	13.1	21.4	-
5	19.8	5.8	24.2	-

[a]C=cooperation condition, NC=non-cooperation condition.

TABLE 4

MEAN TRIADIC DURATIONS (HOURS)

	FD3				WK3			
Group	Conditions[a]				Conditions[a]			
	C	NC	C	NC	C	NC	C	NC
1	3.2	2.3	5.4	-	2.6	none	3.6	-
2	-	4.8	4.6	1.2	-	none	1.4	none
3	-	4.2	5.8	4.5	-	1.8	2.3	none
4	4.7	2.7	3.4	-	2.8	1.3	1.9	-
5	3.6	1.3	5.8	-	2.2	0.4	none	-

[a]C=cooperation condition, NC=non-cooperation condition.

TABLE 5

PROPORTION OF SAMPLES WHERE
SOCIAL INTERACTIONS OCCURRED DURING TRIADIC FD3 EPISODES

Group	Subject	Conditions[a]			
		C	NC	C	NC
3	1	-	.842	.854	.838
	2	-	.833	.878	.897
	3	-	.783	.805	.779
4	1	.774	.834	.609	-
	2	.788	.750	.731	-
	3	.688	.750	.475	-
5	1	.634	.654	.420	-
	2	.653	.615	.420	-
	3	.703	.269	.375	

[a]C=cooperation condition, NC=non-cooperation condition.

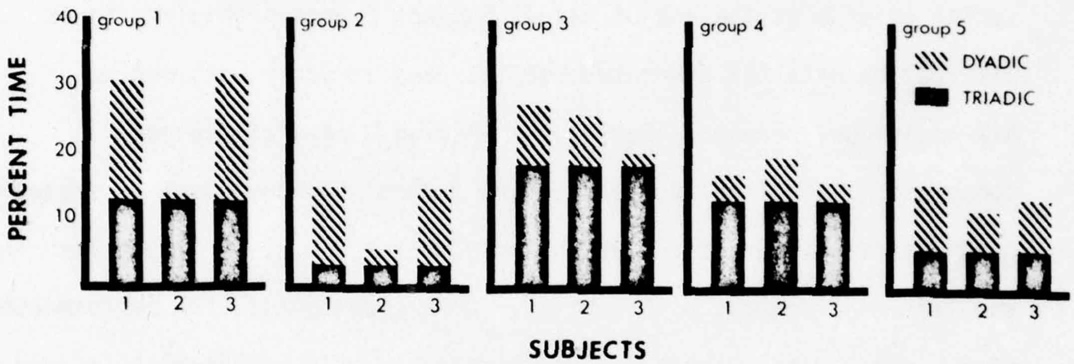


Figure 12. Percent of total time within noncooperation (NC) conditions that all subjects in each group spent in triadic and dyadic episodes totalled across FD3 and WK3 activities. Where two NC conditions occurred for Groups 2 and 3, data have been combined across conditions.

the extent to which motivational and emotional interactions participated in the social contingency effects is suggested by the results observed with the very first group when the change from "cooperation" to "non-cooperation" conditions was programmed. Within minutes after the condition change was introduced during the course of a triadic social episode at the end of day 4, Subject 2 became involved in an altercation with the other two subjects and abruptly returned to his individual chamber. During the ensuing 3 days of the non-cooperation condition, Subjects 1 and 3 continued to engage in frequent dyadic social interactions which excluded Subject 2, as illustrated in the left-hand segment of Figure 12. More importantly, the performances of Subject 2 with respect to the maintenance of "housekeeping" chores in his individual chamber deteriorated and, significantly, the error rate reflected in his "private arithmetic" performances increased dramatically, as shown in Figure 13 during the period immediately following the disruptive emotional interaction (i.e., arithmetic activities 14, 15, and 16). The interacting motivational effects of delayed progress thru the program can, however, be presumed operative in the equally dramatic decrease in error rate which occurred even before termination of the "non-cooperation" condition (i.e., arithmetic activities 17 and 18). In contrast, Figure 14 illustrates the weakening disposition of Subject 2 to engage in less consequential "hobby" activities as reflected in the progressive "shrinkage" of a series of "pot holders" produced in the course of several successive WK3 ("workshop behavior") selections during this same experiment.

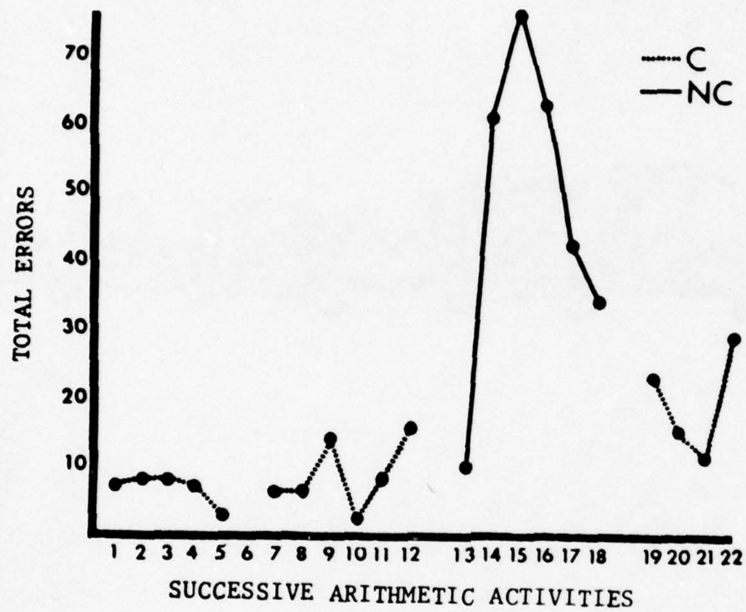


Figure 13. The total errors committed by Subject 2 on an arithmetic task, requiring 100 correct solutions to complete, across successive selections of the arithmetic task activity. C = cooperation condition; NC = non-cooperation condition.

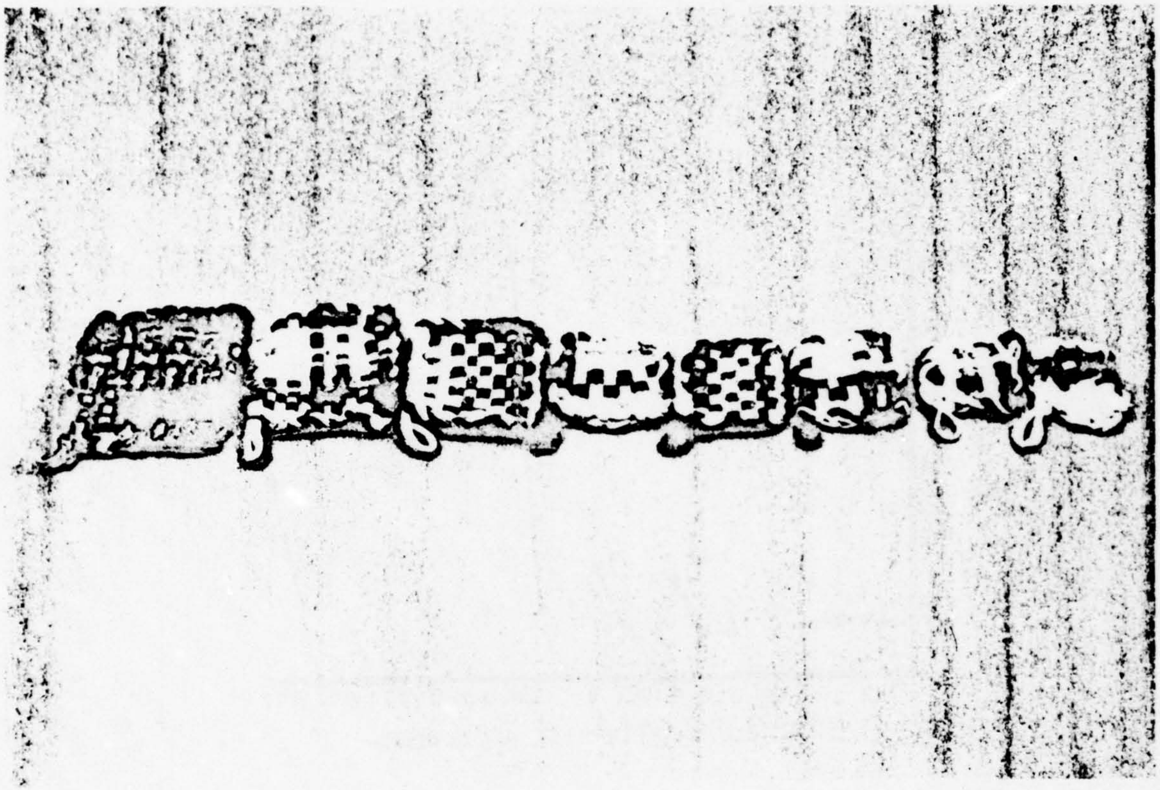


Figure 14. The progressive "shrinkage" of a series of potholders produced by the subject in the course of several successive WK3 activities.

A more extended analysis of such social interaction contingency effects was undertaken with four additional groups of three male subjects each who participated in a series of 10-day experiments to evaluate further the effects of subject pairing on individual and social behavior (Emurian, et al, 1978). In addition to the triadic contingencies studied previously, dyadic contingencies were scheduled when simultaneous occupancy of a group area was permitted to any combination of two, and only two, subjects. Solitary access to group areas also was permitted to parcel out the reinforcing effects of social episodes, independently of those attributable to the accessibility of a larger space. Additionally, included in the behavioral program was a group task that allowed individual contributions to a group criterion that had to be satisfied before triadic or dyadic episodes could occur. This Group Arithmetic Problems (GAP) activity could be selected immediately following the completion of Private Arithmetic Problems (AP). During the GAP activity, the subject could work privately on the problems to contribute to a group criterion of 600 solutions. This criterion had to be satisfied before WK3 or FD3 could be selected by more than one subject, and a counter, present in each private room, showed cumulative contributions to this criterion by all subjects combined. Once a subject had selected GAP, he was required to solve at least one problem correctly before selecting another activity. The GAP task was included to determine the extent to which responding could be maintained by access to different social situations (i.e., triadic or dyadic).

A triadic program condition (T) was in effect when either of two social activities within group areas (i.e., WK3 or FD3) was accessible only when all three subjects selected it together. During this

condition, however, 600 counts on the group task were required before either WK3 or FD3 could be selected by a triad permitting subjects to leave their private rooms and enter the appropriate group area.

In contrast to the triadic condition, a dyadic program condition (D) was in effect when WK3 or FD3 were accessible for social activities by any combination of two, and only two, subjects. As in the triadic condition, 600 counts on the group task were required before WK3 or FD3 could be selected by a dyad. In both conditions, subjects were required to enter and leave the group areas at the same time. Once a group area was occupied by a dyad, access to that area by the third subject was denied until the activity was terminated by the dyad.

For Groups 1 through 4, the dyadic and triadic conditions were investigated in the following order and number of successive days under each condition, respectively: T-D-T (days: 4,3,3); D-T-D (days: 4,3,3); T-D-T (days: 4,3,3); and D-T-D (days: 4,3,3). These sequences were used to control for the effects of the order in which the conditions were presented. For Groups 1 and 2, there was no upper limit on the durations of WK3 and FD3, but for Groups 3 and 4, a 3-hour upper limit was in effect. Throughout social episodes in the recreation room (FD3), 10-second observational samples occurred on a variable-interval schedule averaging 5 minutes between samples. During each observational sample, the subjects' identification numbers (i.e., 1, 2, and 3) were recorded directly on a schematic diagram of the room by two independent observers, giving the subjects' exact location in the room and their proximity to one another. On the basis of these observations, a social distance scale was computed

for each subject reflecting his physical proximity to the other two subjects during triadic social episodes. A given subject's score for a single observational sample was the sum of the distance between himself and the other two subjects. The recordings upon which the social distance scores were based showed high inter-rater reliability (correlation = +.96).

The results of this experiment showed that the status of a closed three-person social system changed when social opportunities were limited to dyads as compared to the triad. Under such dyadic conditions, durations of social contacts were briefer (Figure 15), and performance schedules drifted apart as reflected by decreased levels of harmony in the selection and completion of behavioral program activities (Figure 16). Additionally, daily response outputs on a task having social consequences (GAP) were more often omitted during dyadic conditions (Figure 17). These results illustrate the group fragmentation effects previously observed during a non-cooperation condition (Emurian, et al, 1976) in a situation in which triadic social interactions were prohibited, rather than being optionally available.

Although division of group members occurred in the "non-cooperation" condition of the previous experiments, all subjects continued to have both dyadic and triadic social interactions, and consequently, no subject was ever completely isolated from group activities. In the present experiment, however, group fragmentation effects were stronger during the dyadic condition than observed under the previous "non-cooperation" condition. Under dyadic conditions, three of the four groups in the present study had a lone member who failed to have any direct social contact for several successive days. These differences

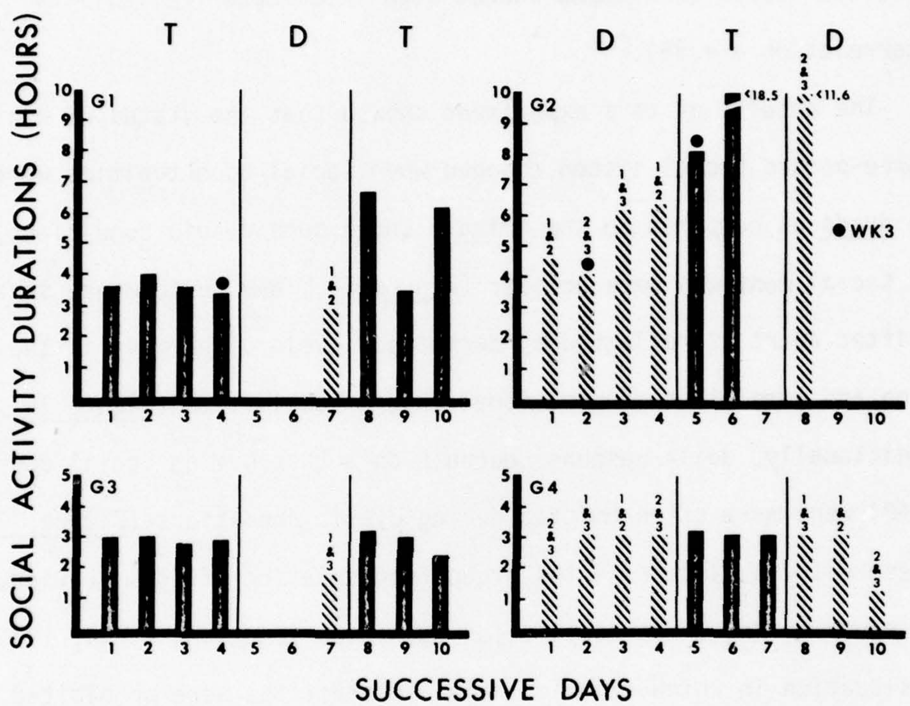


Figure 15. Social activity durations across successive days of the experiment for all groups. Bars represent durations of individual episodes. Numbers above dyadic durations identify the two subjects engaged in the episode. T = triadic condition; D = dyadic condition.

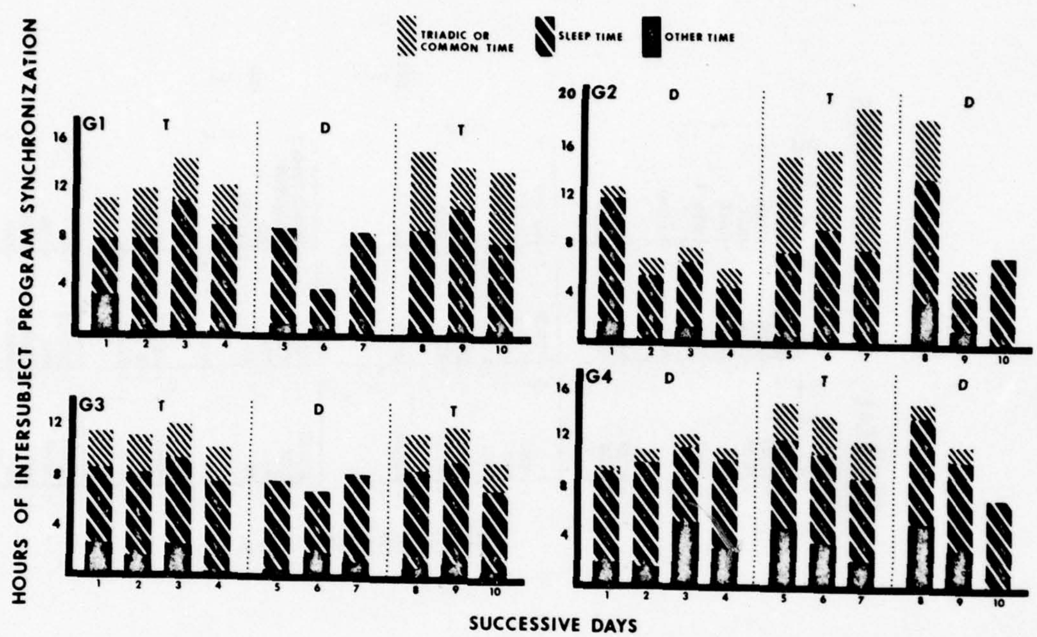


Figure 16. Total hours of intersubject program synchronization for each group across successive days of the experiment. T = triadic condition; D = dyadic condition.

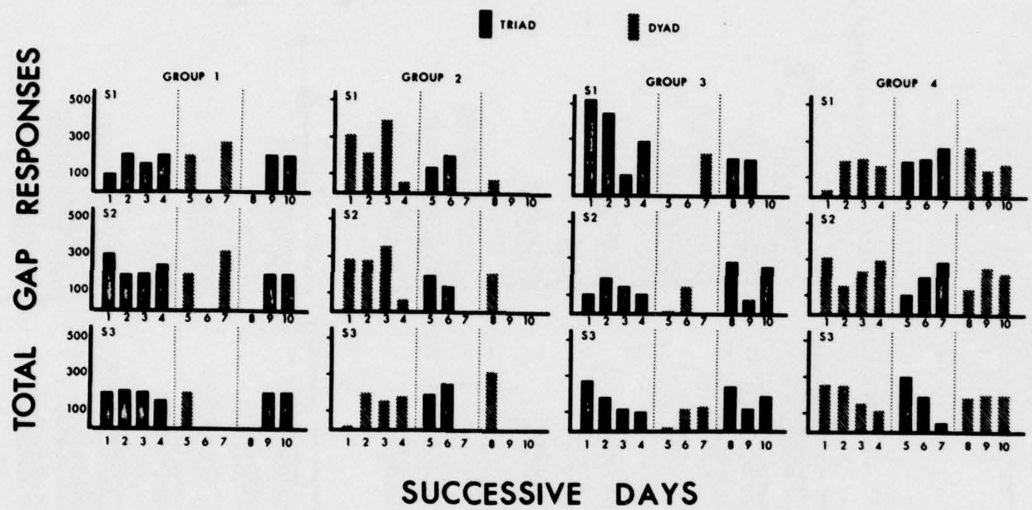


Figure 17. Total group-task (GAP) responses for all subjects in each group across successive days of the experiment.

may be attributable, at least in part, to the more demanding contingencies that were in effect for social contact under dyadic conditions. Under such dyadic conditions, responding was required on the group task, and two subjects had to cooperate in the choice of a group area before social behavior could occur. That dyadic episodes occurred at all when free access to the large group areas was available shows the motivational effects of even such minimal social contact.

The triadic condition was associated with longer periods of social contact than those observed under dyadic conditions. Under triadic conditions, lone members were immediately integrated into social activities that continued to occur on each successive day of the triadic condition. In addition, the triadic condition was always associated with <u>more</u> schedule synchrony among subjects <u>within</u> a given group in comparison to such synchrony observed under dyadic conditions. These latter effects are similar to those observed in the previous study in which the "cooperation" condition produced a greater magnitude of synchrony than the "non-cooperation" condition. Enhanced synchrony observed under both "cooperation" and triadic conditions in the two studies substantiates the motivational effects of triadic social opportunities upon the reduction of intersubject discrepancies in the selection and completion of behavioral program activities.

Of particular interest were the results obtained when the mean social distance scores for all subjects observed over triadic episodes were rank ordered from high to low and plotted against corresponding percents of time in dyadic social episodes during dyadic conditions, as illustrated in <u>Figure 18</u>. A product-moment coefficient of correlation between these social distance scores and percents of time in dyadic episodes during dyadic conditions revealed

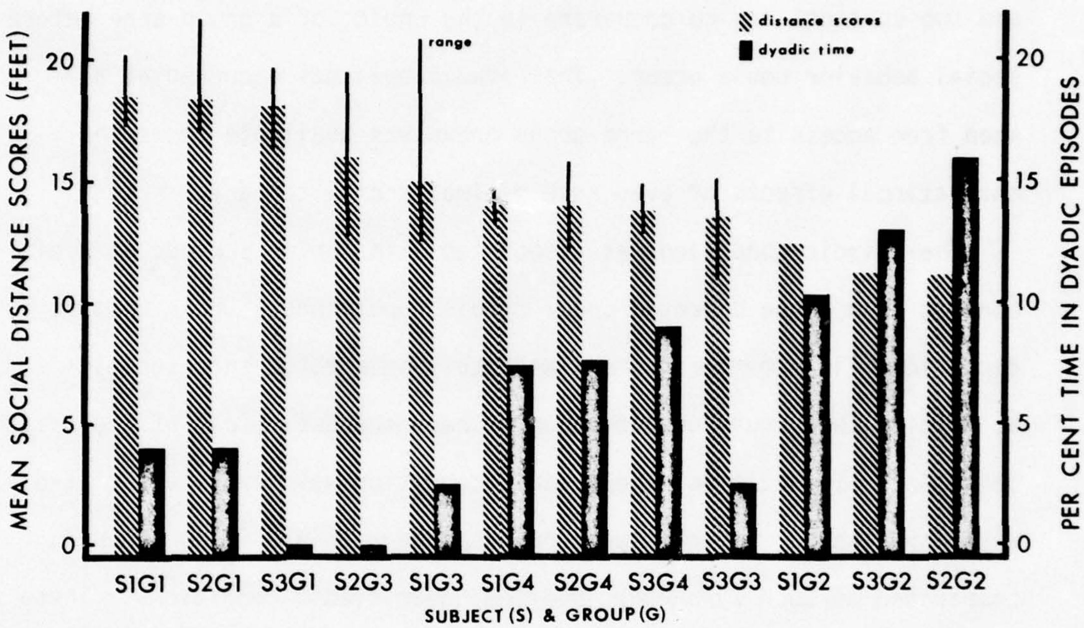
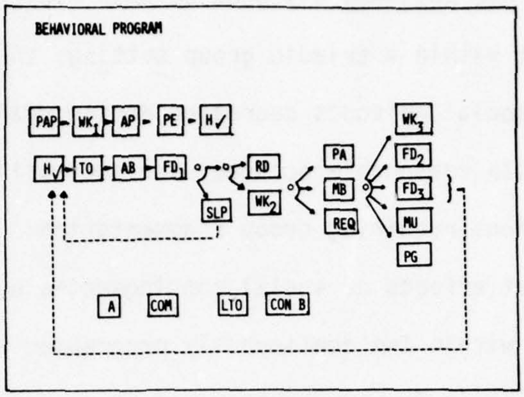


Figure 18. All subjects' mean social distance scores, rank ordered from high to low, plotted against corresponding percents of time in dyadic social episodes during dyadic conditions. The ranges of social distance scores between episodes are given for all groups except Group 2 which had only one triadic episode in the recreation room.

a significant inverse relationship ($r = -.79$, $p < .01$). These data show that as the physical distance between subjects increased for a given subject within a triadic group setting, the proportion of time he spent in social episodes decreased during dyadic conditions, predicting with reasonable accuracy the sociability of group members under conditions requiring group fragmentation.

The robust effects of social contingencies upon the behavior of small groups within the continuously programmed environment has recently provided the basis for some extensions of such group interaction analyses to investigate the role of explicitly programmed motivational operations. Three recently completed 10-12 day, 3-person experiments incorporated a "work unit" completion contingency determining the amount of group remuneration for participation in the study. In all previous experiments, individual subjects received a fixed per diem allowance (i.e., $25) for participation regardless of their performance. In contrast, this recent series of "motivational" studies provided a programmatically controlled amount of remuneration for each completed work unit by an individual subject in the form of a contribution to a group "bank account", with group earnings divided evenly among the participants upon completion of the experiment.

The basic "fixed" and "optional" components of the behavioral program continued to be in effect during these experiments with a sequence of work unit activities made available independently of the remaining sequentially arranged activities, as illustrated in Figure 19. The five work unit activities included: 1) Private Arithmetic Problems (PAP), requiring 200 correct solutions; 2) Work One (WK1), requiring 5000 lever operations; 3) Arithmetic problems (AP), requiring 50 correct solutions; 4) Physical Exercise (PE), requiring 400 correct presses; and 5) Health Check (H ✓),



INVENTORY OF ACTIVITIES

Abbreviation	Full Name	Brief Description	Abbreviation	Full Name	Brief Description
PAP	Private Arithmetic Problems	200 correct solutions to arithmetic problems	MB	*Manual Behavior*	*Access to art materials*
WK_1	Work One	5000 lever operations	REQ	Requisition	Press a lever to earn treats
AP	Arithmetic Problem	50 correct solutions of arithmetic problems	WK_3	Work Three	Social option, access to communal workshop
PE	Physical *Exercise*	400 correct presses on *automated task*	FD_2	Food Two	Private major meal
H✓	Health Check	Temperature, pulse, weight, status report	FD_3	Food Three	Social option, access to recreation room, meal, games
TO	Toilet Operations	*Use of bathroom and contents* of TO drawer, toiletries, clean clothing	MU	Music	5000 lever presses to earn a cassette tape
AB	Autogenic Behavior	Relaxation exercises on cassette tape	PG	Private Games	Access to games drawer
FD_1	Food One	Two selections from a list of light foods	A	Audit	Free access to group "bank account" records
SLP	Sleep	Use of bed and privacy curtain	COM	Communication	Access to intercom
RD	Reading	Access to book	LTO	Limited Toilet Operations	Access to essential toilet facilities
WK_2	Work Two	Problems, experiments, assembly tasks	CON B	Condition B	Used to signal change in program rules
PA	Puzzle Assembly	Assemble a puzzle			

Figure 19. Diagrammatic representation of modified behavioral program showing sequences of independently available work unit activities arrayed upper left above the sequentially programmed behavioral activities.

requiring completion of the health assessment battery. This work unit could be selected upon completion of any activity within the full behavioral program. Once a work unit had been selected, all five activities had to be completed before the subject could resume the behavioral program at the location where the work unit was voluntarily initiated. During a work unit, the Communication activity was unavailable, and subjects were not permitted to use the tape player for music. The parameters for the several component activities were chosen such that 1 to 2 hours were required for completion of a work unit.

The consequences of completing a work unit were systematically varied to assess the effects of alternative behavior-consequence relationships under program control. Throughout the initial four days of the first experiment, for example, a "positive" (i.e., appetitive) relationship was in effect whereby completion of a work unit by an individual subject produced a $10 deposit to the group bank account, the proceeds of which were equally divided among the group at the conclusion of the experiment. Throughout the next four days of the experiment, a "negative" (i.e., avoidance) relationship was in effect such that work units no longer produced $10 increments in the group bank account, but rather were required of the participants in order to avoid withdrawals of similar magnitude. That is, work performance requirements for days 5 thru 8 provided that a $10 withdrawal be made from the group bank account for each uncompleted work sequence below an assigned daily total (i.e., 20) determined on the basis of the group productivity sequences completed per 24 hours. This group requirement could be satisfied under any conditions of individual work scheduling or distribution

decided upon by the group participants. Finally, the last two days of the experiment, days 9 and 10, were programmed as a reversal to those conditions in effect during the first four days.

The work unit contingency maintained substantial productivity levels for all subjects throughout the course of the experiment. No participant completed fewer than five work sequences per day with a range of 5 to 14 units. A distinguishable and relatively stable pattern of group work performances and social interactions emerged during the first four "appetitive" days of the experiment. Although all members of the group were not contributing equally to the group bank account (i.e., one of the three participants consistently completed fewer work units than the other two during this period), a high degree of group cohesiveness was reflected in the social episodes, the intercom exchanges, and the frequent use of the "audit" option available to each participant for monitoring the status of the group bank account and the individual contributions thereto.

In contrast, the second 4-day segment of the experiment (i.e., days 5 thru 8) with work performances "aversively maintained" by avoidance of group monetary resource diminution was characterized by a dramatic change in the relatively stable "work-rest" pattern observed during the first 4 days, and by a progressive deterioration of group cohesiveness. Beginning with day 5, work schedules were drastically altered by the group, and the two productive members of the group became openly intolerant of the third participant's "below-par" performance. As a result, this "low-productivity" participant was progressively isolated from the group and spent days 7 and 8 alone in his private chamber.

Concomitantly, all three members of the group became openly hostile and vehemently expressive of their displeasure with the program control perceived as responsible for this obviously "aversive" state of affairs, as reflected in ratings for days 5 thru 8 shown in Figure 20.

Paradoxically, group productivity as grossly estimated from work unit completions was not materially affected by the change from appetitive to aversive maintaining conditions, and the absolute number of work units completed by the "low productivity" group member (S2) actually increased slightly during days 5 thru 8 as shown in Figure 21. Both the daily work-unit frequency and the total number of hours devoted to work by the group participants were maintained at relatively stable levels throughout the two 4-day intervals, and remained sufficiently high during the "avoidance contingency" in effect from days 5 thru 8 to prevent even a single withdrawal from the group bank account. And on the basis of a more detailed analysis of the several component tasks in the work units as summarized in Figure 22, there is little evidence that performance effectiveness was differentially influenced by the two conditions. This finding is in marked contrast to the dramatic changes in group cohesiveness, ratings of program control conditions, and both interpersonal (e.g., "irritation") and intrapersonal (e.g., "mood") ratings recorded by the subjects during days 5 thru 8.

Although these socially disruptive by-products of the aversive control procedures in effect during the "avoidance" segment of the experiment did not produce obvious decrements in either individual or group effectiveness on work unit performance, changes did occur in the distribution of work units as a function of the transition from

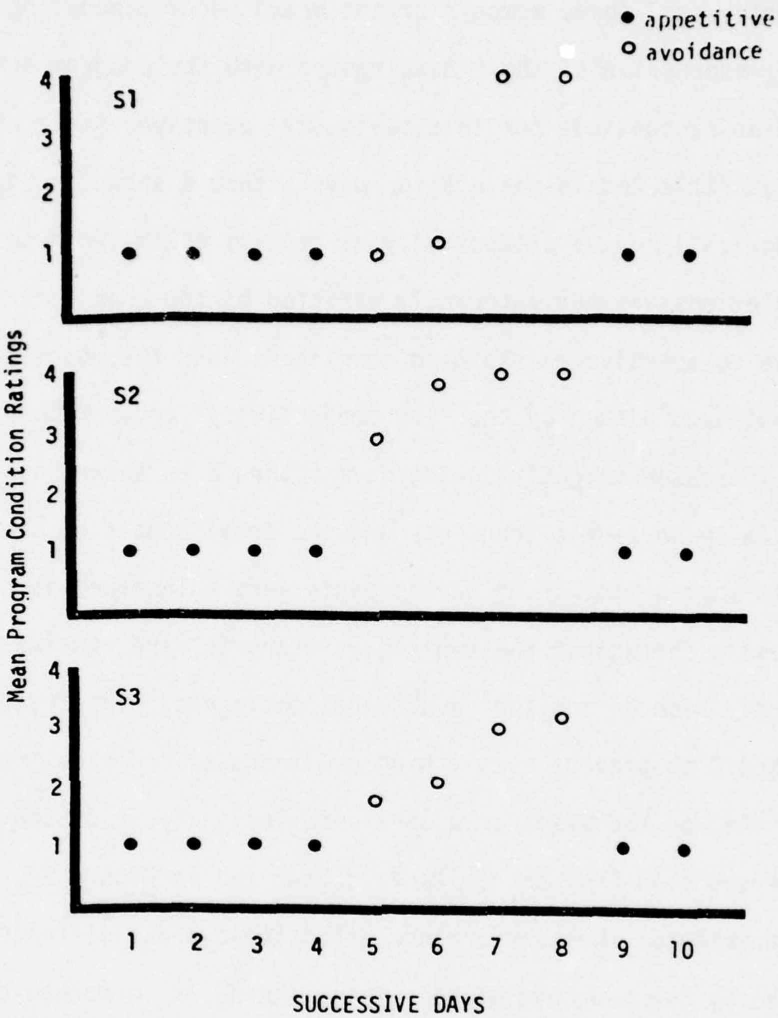


Figure 20. Mean ratings of the experimenters on a 4-point scale progressing from 1 ("not at all irritated at the experimenters") to 4 ("extremely irritated") across successive days of the experiment. Ratings were obtained during each Health Check activity.

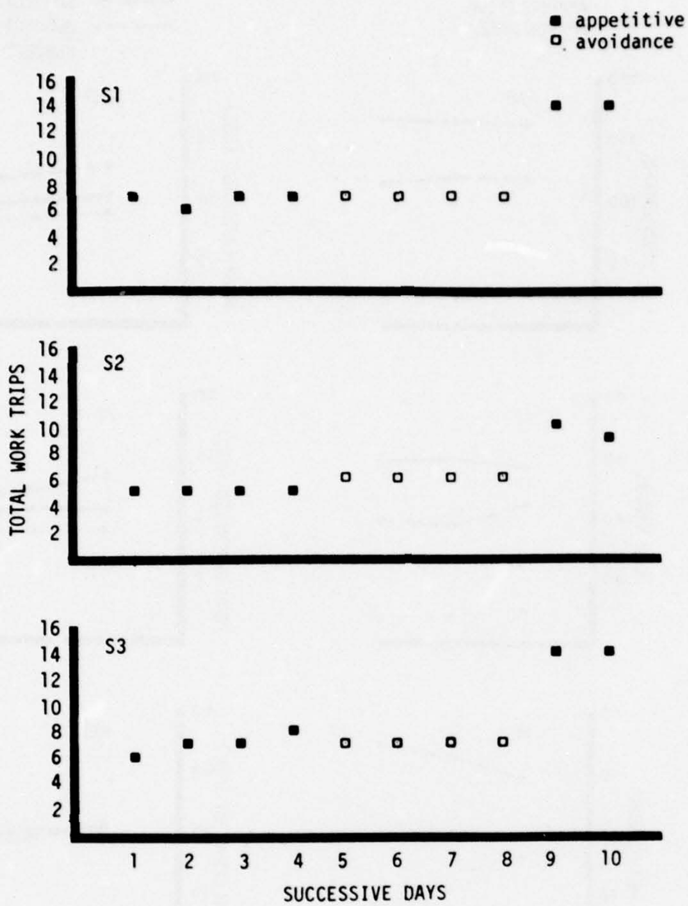


Figure 21. Total work units completed by all subjects across successive days of the experiment.

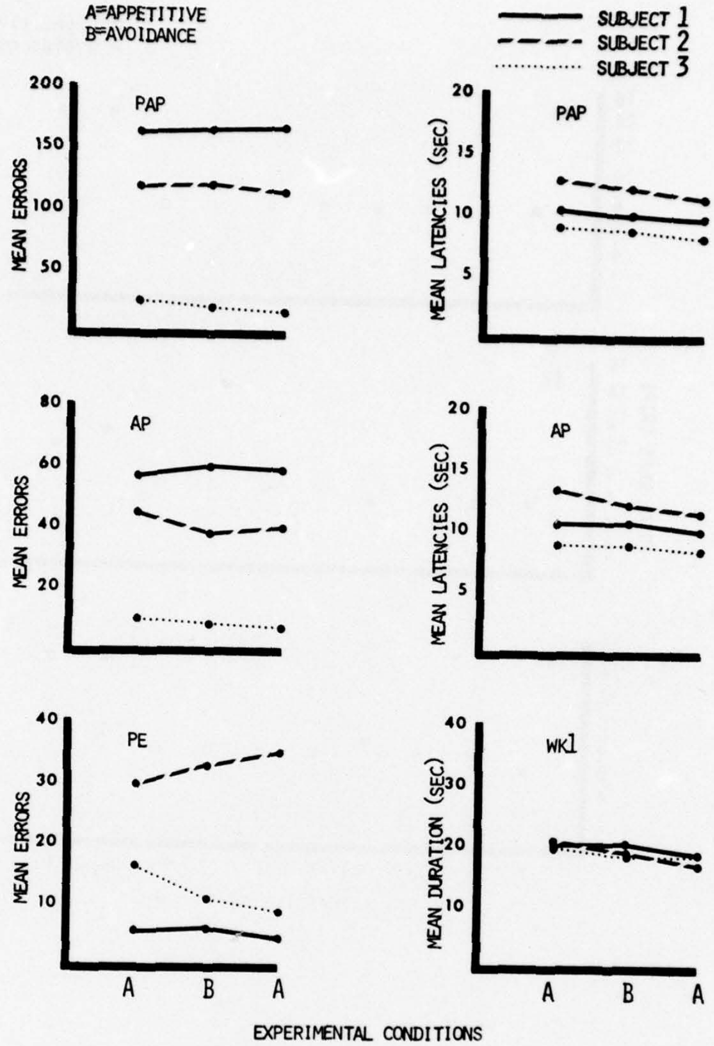


Figure 22. Mean performance effectiveness on the several components of the work unit across successive experimental conditions.

appetitive to aversive motivational conditions. These effects are presented graphically in Figure 23 which shows that the distribution of work unit time (shaded segments) over successive days (depicted as 24-hour clocks) under each of the three program conditions. During days 1 thru 4, the completion of one or two work units was typically followed by a "rest" break during which a social episode (e.g., communal meal) would usually occur. Additional brief work periods would then generally occur interspersed with individual or social recreational interludes before sleep. In contrast, days 5 thru 8 were characterized by a dramatic change in this work-rest pattern with comparable numbers of work units compressed into more restricted time segments as shown on the 24-hour clocks for this "avoidance" period. This alteration in the temporal distribution pattern effectively insured that the daily group performance requirement (i.e., 20 work units) was completed before any social or recreational episodes occurred. Significantly, the progressive deterioration of group cohesiveness, shown in Figure 24 by the progressive decrease in triadic social interaction over days 5 thru 8, developed concurrently with this change in the work-rest pattern.

The extremely high work rates reflected in the 24-hour clock distribution for days 9 and 10 following reversal to the appetitive "motivational" conditions of days 1 thru 4 probably accounts at least in part for the "group fragmentation" which persisted throughout these final two days of the experiment. While this final "burst" of work activity can be attributed to some combination of "emotional" facilitation occasioned by the condition change (i.e., from aversive to appetitive control) on the one hand, and the "motivational"

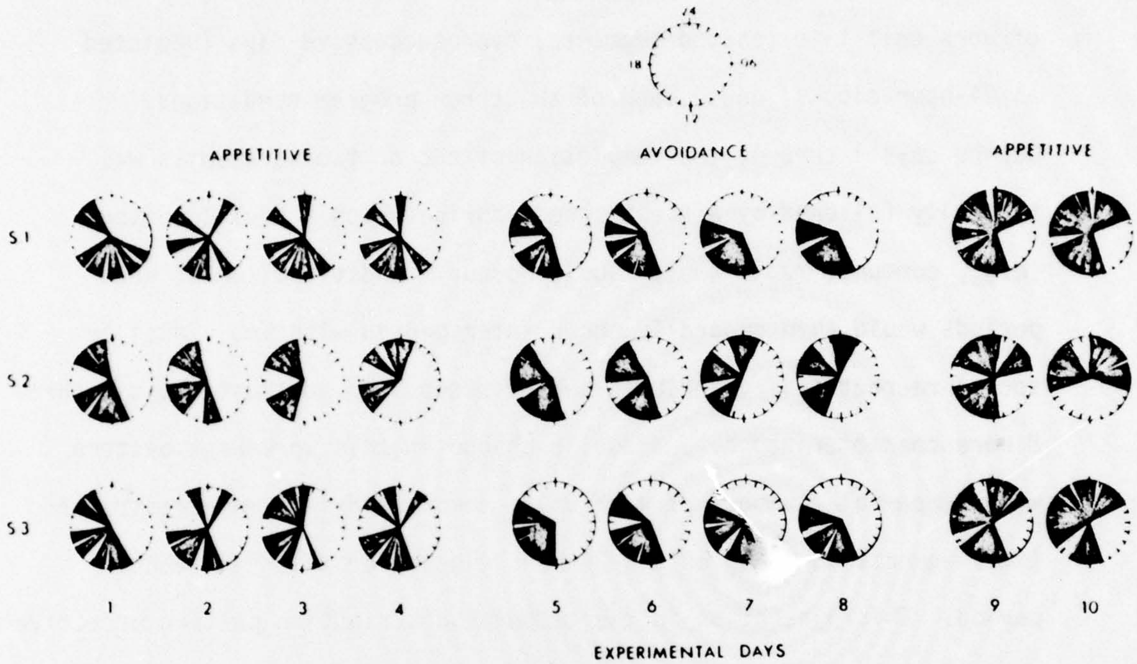


Figure 23. The *distribution of work unit* time (shaded segments) over successive days (depicted as 24-hour clocks) under each of the three program conditions.

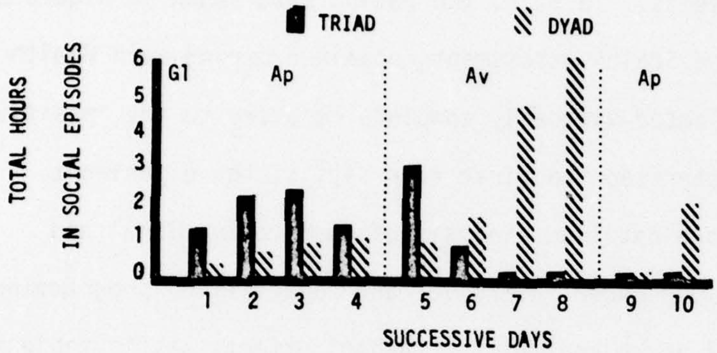


Figure 24. Total dyadic and triadic time in minutes over successive days of the experiment.

potentiation produced by temporal proximity of the behavior-maintaining consequence (i.e., the "pay-off" at the end of the experiment), it is noteworthy that this extremely high work output (far exceeding those levels observed during any of the 25 previous experiments conducted in our laboratory) occurred in the absence of any deleterious side effects to the subjects. In fact, the rating data shown in Figure 20 along with the "Mood Scale" assessments obtained during each Health Check activity reflected virtually complete recovery to the "positive" levels which characterized the first four days of the experiment.

To provide a more detailed analysis of such motivational and emotional interactions under "aversive" and "appetitive" programming conditions, as well as to control for "order" effects attributable to the temporal sequence in which these diverse programming conditions were presented, two additional 12-day experiments were conducted, one with the three male participants and one with three females. The experimental methodology and general programming procedures were basically similar to those illustrated in Figure 19 with the exception that an expanded group of work unit activities (e.g., perceptual, memory, vigilance, etc.) was programmed for the second group of male subjects, and the order and number of days of exposure to the appetitive and aversive conditions were varied. Both groups resided in the continuously programmed environment for twelve days with the appetitive (Ap) and avoidance (Av) conditions in effect in the following order and number of successive days under each condition, respectively: Ap-Av-Ap-Av (3,3,3,3), and Ap-Av-Ap (3,6,3).

As with the first group, the work unit contingency, requiring approximately one hour for completion, maintained substantial productivity levels for all subjects in each of these two additional

groups. Figure 25, for example, summarizes the total number of work units completed by all subjects across successive days of the three group studies. No subject completed fewer than two work units per day (e.g., Subject 2 in Group 2 on Day 1) with a range of 2 to 16 units. Within all groups, the work unit outputs were more evenly distributed among subjects during the avoidance condition in comparison to such distributions during the appetitive condition. A comparison of the differences between the highest and lowest work frequency for all subjects in each group, under the assumption that such differences approach zero when variability is absent, between the two conditions showed a significant effect.

Subjects with a relatively low daily work unit output during the first appetitive condition showed a work unit performance increment during the succeeding avoidance condition (e.g., S2G1, S2G2, S3G2, and S2G3). And Group 3, like Group 1, showed a dramatic increase in daily work unit frequency when the appetitive condition was reintroduced for the final 3 days of the study. The less than dramatic change in this regard observed with Group 2 can probably be attributed to some combination of the more demanding requirements of the work unit activities programmed for this group (i.e., the motivational effects of increased "response cost") and the order effects produced by multiple condition reversals and termination of the study with the avoidance contingency in effect (i.e., the emotional effects of aversive occasioning circumstances).

With respect to the intrapersonal aspects of the program condition effects, almost all subjects reported "mood" changes between program conditions on the Depression factor of the Lorr's Outpatient Mood Scale which was administered during each Health Check activity. Eight of the nine subjects showed the highest ratings during the

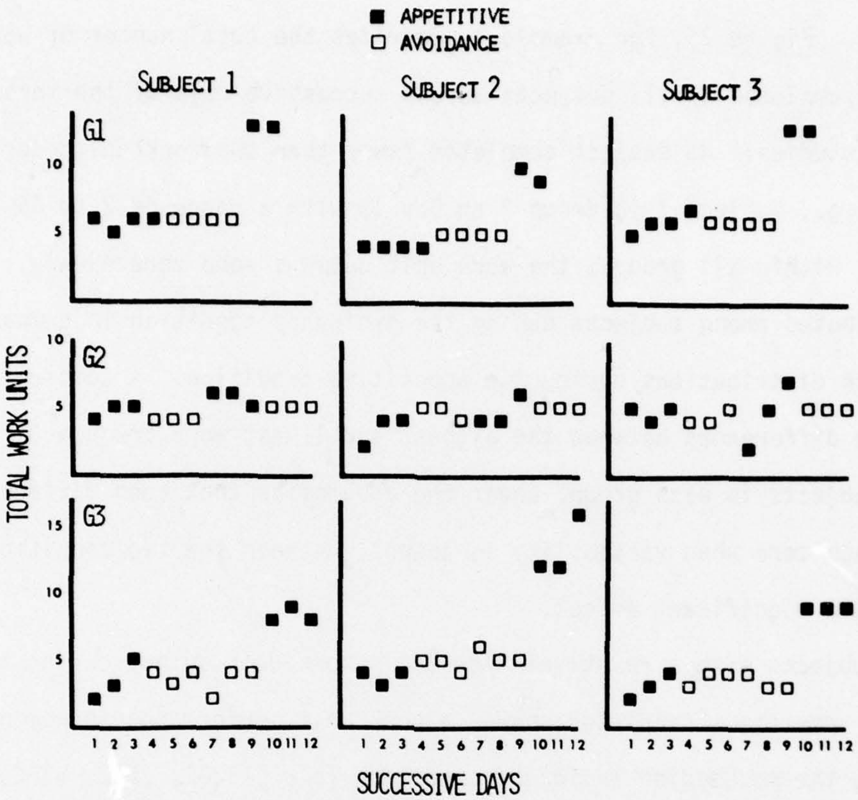


Figure 25. Total number of work units completed by all subjects across successive days of the three experiments.

avoidance condition, and, for a pooled analysis, the avoidance condition was associated with significnatly higher depression ratings. Additionally, Figure 26 shows that on a 4-point scale reflecting "degree of irritation" (1=none to 4=extreme) with the program condition, all subjects in each group displayed more irritation during the avoidance condition than during corresponding appetitive program conditions.

As with Group 1, the three male subjects in Group 2 showed local effects of the avoidance condition in the form of clear displays of aggression. Members within Group 2 evidenced destructive behaviors in relationship to laboratory property (e.g., kicking the walls and damaging the furniture) and repeatedly failed to conform to the requirements of the behavioral program. In contrast, the three female subjects in Group 3 displayed no such aggressive or hostile behaviors even after 6 successive days under the avoidance contingency though their program rating scores (Figure 26) did show a modest degree of intermittent irritation in the course of this extended exposure to the aversive avoidance condition.

The results of these several residential studies illustrate the development and application of an effective and relevant experimental methodology for the analysis of motivational and emotional interactions in a continuously programmed laboratory environment. The initial observations showed clearly that small groups of individuals could not only be maintained under naturalistic experimental conditions for extended periods of continuous residence, but that the sequential contingency performance program developed for these studies was productively supportive of both individual and social behavior interactions. Moreover, these studies

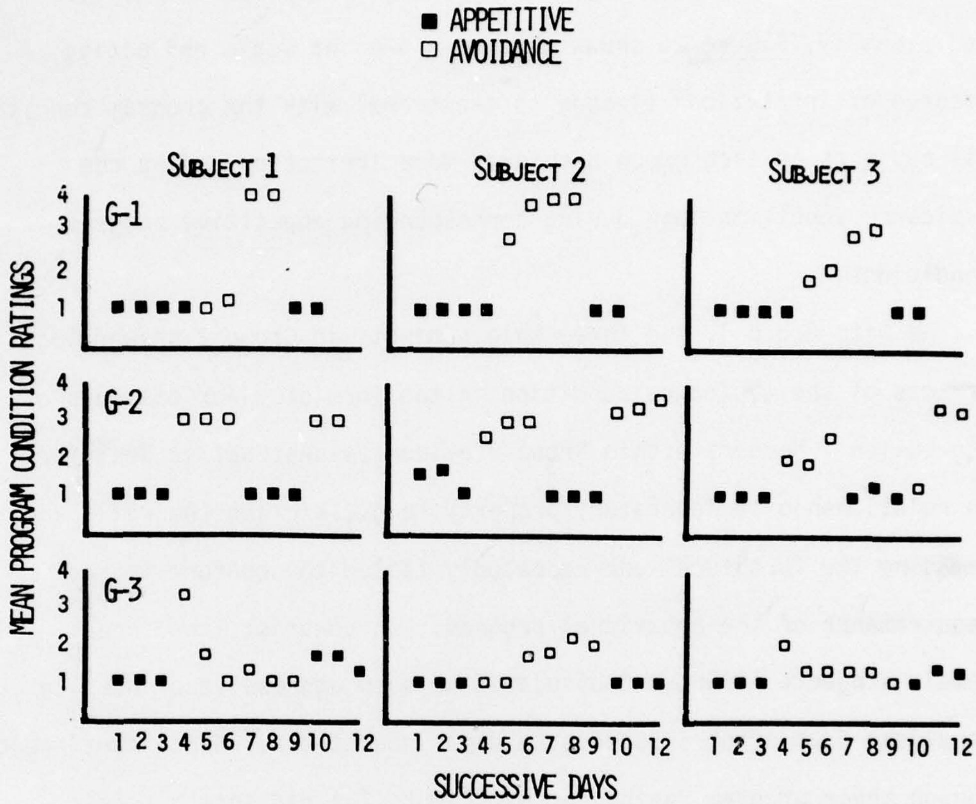


Figure 26. Mean daily ratings of the program condition on a 4 point scale reflecting degree of irritation (1=none to 4=extreme) for all subjects in each group.

confirmed the sensitivity of such behavioral interactions to environmental manipulations within the time frame of a given experiment (i.e., program conditions changes and reversals), and emphasized the importance of specific program components (e.g., social activities) as maintaining consequences for the performances upon which their access was made contingent.

Motivational operations in the form of program condition changes potentiated the reinforcing functions of social consequating events, and performance enhancement was observed under circumstances which made access to group activities contingent upon cooperative behaviors. In contrast, when this cooperation contingency was not in effect (i.e., non-cooperation condition), group fragmentation and individual performance deterioriation occurred. Additionally, emotional influences upon the occasioning circumstances for both individual and group performances within the programmed environment were interactive with motivational functions. The effects of such emotional interactions were evident not only in the more dramatic disruptions of individual performance baselines (e.g., Figure 13), but as well in the less obvious relationship between social distance and dyadic social engagements observed under pairing contingency conditions (e.g., Figure 18). Operative emotional influences upon the occasioning circumstance provided by simultaneous presence of all three group members in the social living area (i.e., triadic episodes upon which social distance measures were based) were found to interact in an orderly and systematic way with motivational operations which potentiated the reinforcing functions of paired social transactions (i.e., dyadic episodes upon which social time measures were based).

The complexity of these behavioral functions was perhaps most prominently displayed in more recent studies which have begun to address critical dimensional and parametric aspects of motivational and emotional interactions. The motivational effects of contrasting appetitive and aversive performance-maintaining consequence potentiation, for example, clearly interacted with emotional functions expressed obtrusively as effects upon interpersonal occasioning circumstances provided by program condition requirements (e.g., Figures 20 and 24). Superordinate motivational functions were nonetheless evident in the consequence potentiating effects which not only prevented work unit decrements under such aversive programming conditions (e.g., Figure 22), but in notable instances actually enhanced performance levels (e.g., Figure 21). Even more powerful motivational influences were evident in the performance enhancement observed under appetitive conditions when the behavior-maintaining monetary consequences of subject participation were potentiated by temporal proximity of the "pay-off" upon termination of the experiment (e.g., Figure 21, days 9 and 10).

Finally, of more than coincidental interest from the standpoint of a parametric analysis of such motivational and emotional interactions would seem to be the very striking, if obviously preliminary observation differentiating the behavior of the male and female group participants under essentially similar program conditions. Data limitations necessarily preclude even tentative conclusions based upon the observed variations, though the findings do suggest a potentially fruitful course for future experimental analysis of the somatic, associative, and hedonic influences, both contemporary and historical, which determine the commonalities and differences in motivational and emctional attributes of behavior.

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